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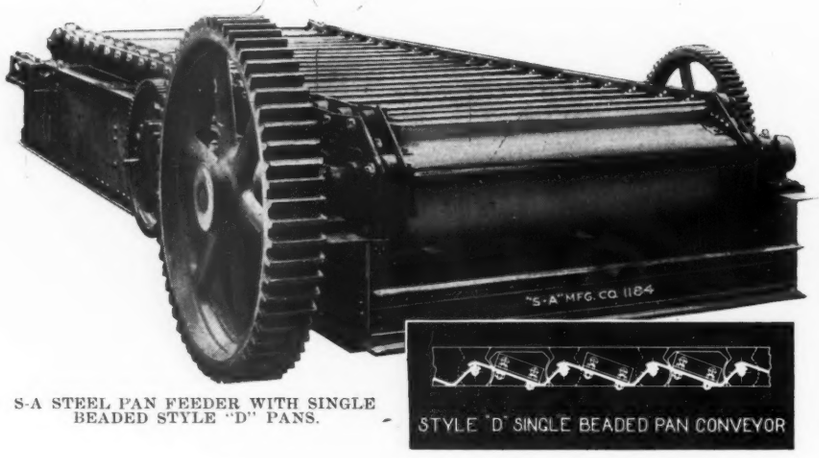
March 3, 1923



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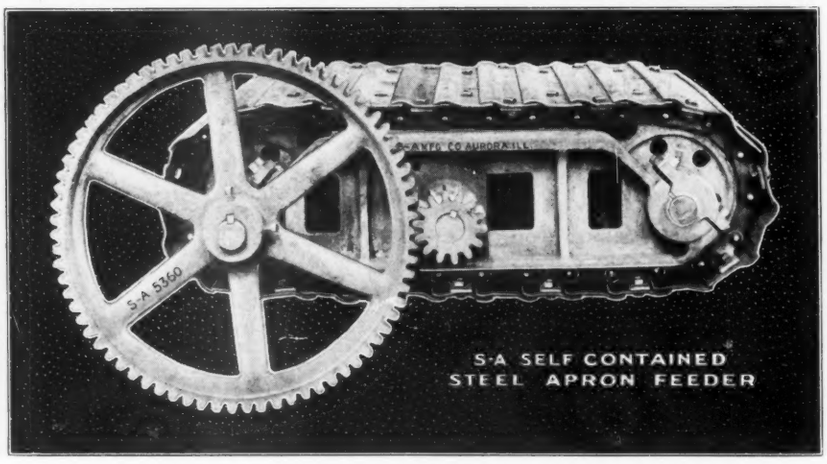


ENGINEERING & MINING
JOURNAL-PRESS
JOSIAH EDWARD SPURR, Editor

Volume 115 **New York, March 3, 1923** *Number* 9

Celestial Geology

THE TERM which we have written above is ambiguous, at the least, but we use it for want of a better to designate the investigation of that science of the heavenly bodies which on the earth is designated "Geology." These unattainable spheres which shine in the heavens have their own history, like and yet unlike the earth's, and what may be ascertained on one sphere may and does assist the comprehension of what has taken place on the others.

The sun, for example, a flaming ball of gaseous elements, was where the element helium was first discovered—not on the earth. The name comes from the Greek word for sun—"helios." The astronomer Lockyer in 1868 detected helium in the sun by means of the spectroscope, and this led to the search for it on the earth, but it was not until 1895 that it was discovered by Ramsay in the mineral cleveite. Now it has been isolated in large quantities and is of prime commercial and political importance as the best gaseous filling for dirigibles and other balloons. Other terrestrial lessons have been drawn from the sun. Thus, a petrologist, Dr. H. S. Washington, of the Carnegie Geophysical Laboratory, has referred to the astronomer Abbot's tabulation of spectrum intensities in the sun, and to Abbot's belief that "the decrease of intensities with increasing atomic weights seems to depend upon the depth of these gases below the sun's surface." The heaviest elements, like copper, zinc, silver, tin, and lead, are thus inferred to lie deepest in the sun's mass, the lighter rock-forming elements, like lime, iron, silicon, sodium, magnesium, and aluminum, to characterize the superficial region. Dr. Washington assumes a similar history for the earth, and hence argues for a metallic interior of the earth, beneath the rock crust—a metallic interior from which mineral veins are feeble upshoots.

The moon, closest and best known of our unattainable celestial neighbors, is becoming still better known to us, as increasingly clear and close photographs are taken. It is a waste and weird volcanic wonderland, like a volcanic desert on the earth, and yet grotesquely different. Its immense craters, which pockmark its surface, are usually far wider than terrestrial craters, a phenomenon due to the moon's lesser volume and specific gravity. A certain accumulation of volcanic gases will shoot a much bigger crater hole on the moon than on the earth. But they show many of the characteristic features of earth volcanoes, including some denied by earlier students who had only inferior photographs as evidence. The characteristic minor inner cones within craters, the flanking of subsidiary cones, the breached wall and minor lava flow, are all present. Many of the craters are simply gas craters, and long fault scarps are plainly visible, along which minor craters are ranged, just as the basaltic cones are lined up along the fault line at the east face of the Sierra Nevada. There are also great flows of lava, forming smooth plains, doubtless proceeding from fissure eruptions such as we have had on the earth. These plains, although their nature is now recognized, are still called by the Latin words for sea, bay, lake, and ocean (mare, sinus, lacus, and oceanus). These terms date back to the period before the absence of water was determined. Milton pictures Galileo, the "Tuscan artist," on the mountain top studying the moon's face:

> "To descry new lands
> Rivers or mountains on her spotty globe."

The lack of moisture and atmosphere on the moon, and the consequent absence of rain, rivers, and water bodies of all sorts, eliminates that most powerful and far-reaching earth-agency, erosion, with the long train of terrestrial unrest which it entails. In the future, geologists will be able to enlighten astronomers as to the meaning of moon features; and the knowledge which they themselves gain will be of great use in interpreting earth-phenomena. There are ranges of ancient mountains in the moon whose towering and rifted grotesqueness will instruct us as to the results of diastrophism where erosion is absent and where gravity is a minor force than that which we know; and thus we may be able to evaluate earth-processes whose solution we have yet hardly attempted. Many of the white areas and radial lines on the moon, which yet puzzle astronomers, are probably the far-flung sheets and streaks of volcanic ash and dust, unhampered by wind or rain or by the gravity attraction such as that of the earth. As for ore deposits, it may interest prospectors to know that they almost certainly exist upon the moon, but that on account of lack of erosion they are little exposed at the surface, though they should be exposed along some of the great rifts and faults. It will be tantalizing to some of our readers to be unable to fit out an expedition to investigate.

The Breadth of Engineering

ARTIFICIAL BARRIERS between the branches of engineering are disappearing rapidly. Technologists can no longer hope to succeed at their work if they adopt an insular attitude. The electrical engineer finds himself becoming interested in metallurgical and other processes that will provide compensation for a load factor that is fluctuating. The civil engineer who uses concrete follows the problems that are being solved by the ore dresser, who is concerned with the reduction and the grading of rock. The metallurgist who has to treat a slimy ore finds that much work of interest and value has been done by the agriculturalist in his researches on colloidal soils. The man in charge of a tube-mill plant learns that the Department of Roads and Rural Engineering has experimented with the testing of rocks used for road metal; he concludes that the information available is equally applicable for use in the selection of a suitable pebble for his purpose.

The mechanical engineer discovers that a knowledge of chemistry is necessary to appreciate the reasons why a maximum percentage of carbon dioxide is desirable in boiler-flue gases. The chemical engineer is interested

in the application of machines that have been developed by the metallurgist. The constructional engineer must keep himself posted in the trend of progress in relation to plants and processes. The rubber technologist wants to know how cheaply zinc oxide or gas black can be made, because he has to use one or both of them as a filler in tires. The synthetic nitrate engineer appreciates reliable information on whether the process used for making nitrate from Chilean caliche can be cheapened; the operator on the pampa, on the other hand, is interested to a like degree in whether nitrogen can be extracted from the air and manufactured into suitable products at a profit.

The locomotive engineer needs to keep abreast with the modern trend of thought in favor of electric traction. The railway engineer is concerned with the inroads being made by bus and motor-truck transportation. The steam-plant engineer finds himself interested in a possible competitor—the internal-combustion engine of the Diesel type. The mining engineer in the mountains is appreciative of the advance made in the manufacture of acetone and alcohol as byproducts from the distillation of volatile matter from wood, for motor fuel is expensive. The lumber-mill engineer would like to know something about the plants that are used to make commercial salt, for he has brine under his ground and would utilize the exhaust steam. The automobile engineer is interested in the supply of lubricating oil and liquid fuel; when something new develops in connection with the steam car, he wants to know about it. The advertiser goes to the psychoanalist for data in regard to the science of advertising.

These examples might be multiplied indefinitely. They serve to indicate the need for a catholic outlook and a sympathetic appreciation of the advances being made in other industries.

Science has been defined as a divine inquisitiveness. An engineer who broadens his range of vision will find much of interest and profit in his excursions into the unfamiliar.

Gold a Precious Metal Through the Ages

FEW OF US have not been stirred by the artistic accomplishments of 3,400 years ago as revealed by the excavations now being carried on near Luxor, Egypt. Mining men are no doubt surprised at the wealth of gold, bronze, and precious stones that are stored in the tomb of Tut-ankh-amen. Where did all this gold come from and how was it recovered from its natural deposits? Metallurgy was no doubt crude in those days, but it was evidently effective. Those who are interested now in the gold industry will note with satisfaction the renewed assurance that gold has persisted as the emblem of wealth and as an object of adornment for more than thirty-four centuries. After this record it can hardly be discarded as a metal not worth the mining, as some present-day economists and others would have us believe. It has had a long and honorable history, and any aspersions that may be cast upon its value and use by those nations who now possess little of it, will, no doubt, be forgotten in a few years.

Another thought occurs to us as we read of the Egyptian revelations. Already clothing and jewelry designers are sending representatives to see and be inspired by the antique treasures. An Egyptian era of style is being predicted, with women's clothing following the ancient lines, and jewelry and *objets d'art* modeled after those which were fashionable in King Tut's time. This may well be reflected in an increased demand for gold for commercial purposes, which, according to one's economic belief, may or may not be a good thing for the gold-mining industry as long as it is sold at the fixed price of $20.67 per oz. In the last few years, platinum has displaced gold to a certain extent in jewelry. This is chiefly because it is more expensive, for platinum has not the beauty of either gold or silver, and does not set off a diamond nearly so well as the more colorful metal. The vogue of platinum is likely to be limited, but that of gold persists through the ages.

The Pay of Engineers

WE DO NOT KNOW who Henry Walker is—he is not listed in "Who's Who in Engineering"—but we take a large measure of exception to an article of his which is featured on the first page of the magazine section of the *New York Herald* for Sunday, Feb. 18. It is entitled "The Engineer and His Earnings," and we select the following crumbs as typical:

"Engineering salaries average far higher than those earned in any other profession, the rate being almost $5,000 a year."

"Success often comes to the engineer very early in his professional life while he is young enough to enjoy it."

Mr. Walker mentions particularly the incomes of civil engineers, about which he presents data collected by the American Society of Civil Engineers, but, he says, "the civil engineer is not the highest paid class among the total of engineers in general. Probably the mining engineer would show a higher average, as well as a larger number of extraordinary fees and high salaries."

We believe the entire article will be read by engineers with considerable surprise, for engineering is a notoriously poorly paid profession at present. Three or four years ago Cornell University sent a questionnaire to its graduates who had left college ten years before, asking them what they were doing and what their income was. The replies were tabulated and the incomes derived by graduates in various kinds of work were classified and averaged. They were as follows:

Number Reporting	Activity	Average Yearly Income at End of Ten Years
10	Bankers and brokers	$11,040
36	Manufacturers	8,524
18	Physicians	7,944
7	Architects	7,230
31	Merchants	7,136
29	Lawyers	5,905
41	Salesmen	5,690
3	Purchasing agents	5,600
4	Advertising	5,476
5	Newspaper	5,180
5	Accounts and statistics	5,004
6	Insurance	4,533
14	Farmers	4,461
15	Builders and contractors	4,287
7	Veterinarians	3,921
83	Engineers	3,724
33	Teachers	3,137

It will be seen by this table that engineers rank next below veterinarians, and only one notch above the lowest paid class of all—teachers. Since then, we understand, the salaries of teachers have been considerably increased. It is of note, further, that Cornell has one of the best engineering schools of the country, so that the abilities of the engineering graduates should be above par.

Beyond doubt there are some engineers that have

been remarkably successful financially, and of course it is these that Mr. Walker picks as examples. Regarding John Hays Hammond he says: "Legends have naturally clustered about him, and especially while he was in the limelight of the South African turmoil, and later, in 1908, when he was a candidate for the Vice-Presidency, there was a good deal of exaggeration, but the sober facts, with all the necessary discounts from gossip, are impressive enough. In 1903 he was employed by the Guggenheimers (sic) at a salary of $250,000 a year, and before long this was doubled. This was undoubtedly the largest salary ever paid to any man as a salary—a continuing income, which lasted for several years. And that was not all, for it was credibly reported that additional commissions and extra payments brought the average up to over $800,000, and eventually a million. And, according to the widely published gossip of the time, it was said that Mr. Hammond did not regard this as satisfactory, and asked for $1,200,000!" And this is what is being fed to the young and impressionable, in a series of articles designed to weigh the pecuniary rewards of the various professions.

Again, we read "There is further advantage that the profession is not, as yet, overcrowded, and there is small likelihood that the supply of competent men will exceed the demand, even with the large increase of educational institutions." That is just what is the trouble with the engineering profession: it is decidedly overcrowded. In the *New York Times* of the same date an advertisement appears for a graduate electrical engineer, a mechanical engineer, and a chemical engineer, E. E., M. E., and Ch. E., two to six years' experience, salary $150—$175 a month. No self-respecting bricklayer or painter or carpenter would accept such a salary, and yet we have no doubt that applications will be numerous.

No, there are plenty of engineers who are compelled to sell their ability for a ridiculously small amount. And the reason there are so many engineers is because engineering is constructive work that appeals to the imagination. The work takes one about the country more, possibly, than any other profession. It appeals to the spirit of adventure that is latent in most of us; it also appeals to the scientific side of our natures which has been fertilized by so many recent wonderful developments in electricity and transportation. Witness the thousands that delight in monkeying with radio. We are, therefore, willing to accept a smaller financial reward because we like the work better, for example, than that of the lawyer, who must concern himself entirely with the disagreements and misconduct of the human kind. If we must have money soon after graduation, we take up dentistry or a similar profession in which the young graduate is practically assured a good income in the first year or two after he leaves school.

This idea of lower pay for congenial work and the opposite of this concept, higher pay for unpleasant work, is much more in evidence now than a few years ago. With the increased educational advantages that the present generation enjoys, a smaller proportion of the population wants to be bricklayers; therefore the wages of bricklayers seem unduly high to those who think in terms of the conditions that existed ten or twenty years ago. We would rather be engineers and take a chance on reaching the pinnacle of financial independence that such a small proportion of those who adopt that profession attain.

Avian Metal Consumption

FROM that always entertaining page in the London *Ironmonger* written by "Vulcan" we obtain another idea for extending the uses of metals which is a fitting supplement to the valuable suggestions given in an editorial in the Sept. 30 issue of the *Journal-Press* on "Touracos and Copper." This also has to do with birds. According to "Vulcan," in the English village of East Riggs has been found a bird's nest made of intertwined beech twigs and iron wire.

"The birds which constructed this house for their young have not been identified, but a South Kensington authority who was informed of the discovery reported that the use of iron wire and metal shavings in birds' nests is not unusual, and produced one built by a 'foreign bird' in which strands of wire were prominent. It seems to me that here is a great field lying waiting for the development of trade. How to get at the birds is the main thing. I would suggest that a number of ready-made wire nests be hung up in the woodlands to serve as models. These might be followed by leaving about a supply of suitable lengths of wire, duly provided with the new British Wire Netting trademark. After a time when they—the feathered songsters of the grove—had learned to imitate the ready-made tradenests, a stock of these, duly priced (prompt cash, net), might be laid out in a prominent place, whereupon I am certain a large demand would follow. It never struck me till this instant in what way the birds are to make payment, except in eggs, and there is no great eating in a wren's egg. Besides, if all the eggs are eaten, there will be no birds; and no birds, no wire-nests. But I do not think my fine idea should be crushed under a detail of mere economics. In some respects I am closely related to the little schoolgirl who, when asked the meaning of the hyphen in 'bird's-nest,' answered that it was for the bird to sit upon."

Personally, we feel that our principal clients, the ultimate producers, will care little about how the birds get their iron or copper wire. Even if they follow their natural inclination and steal their building material, consumption will still be increased and it will be necessary to mine more metal than otherwise.

The Selukwe Company in British Columbia

THE London mining market has been ruffled of late by delightful flutterings of speculative activity, caused by favorable news from sundry mines in widely separate regions. The shares of the Cam & Motor company, owning a gold mine in Rhodesia, have risen from a low quotation of 7 shillings last year to 55 shillings per share on the finding of rich ore on the 12th level. The shares of the Selukwe company, which has had a disappointing experience in Rhodesia, have jumped recently from 8 shillings to 29 shillings on the report that the extension of the Premier lode has been cut in its new property in the Salmon River district of British Columbia. Our readers know the Premier mine and can appreciate what a flutter of hope might be occasioned by such an item of news as the intersection of the lode of that mine in a neighboring property, but it seems a little too optimistic to suppose that the finding of a lode, not necessarily a rich orebody, in a piece of mining ground in British Columbia should treble the market value of the holdings of a company that has a capital of $1,000,000. We hope the Selukwe claims in British Columbia will prove as rich as anticipated; we would like to see this English company fulfill the utmost expectations of its shareholders; but undue optimism may facilitate manipulation.

DISCUSSION

The Prohibition Question in the Philippines

THE EDITOR:

Sir—I, like the Australian who asked you what the effects of prohibition were on the mining industry of the United States, have been curious to know and, from the letters in your Nov. 18 issue from different mining men, it is not hard to decide. Those who tried to be superlatively judicial admitted, between the lines, that conditions were no worse than in the old, wide-open days. Others were decidedly decided and gave reasons for it. It put me in mind of my pioneer days in Leadville, Telluride, and Ouray, where everything was wide open with the bridle off and no railroad. Some good men argued that to close the saloons, suppress gambling and bring in a railroad would "bust the camp."

From what I can learn at this distance it appears about as likely that the Eighteenth Amendment will be rescinded as it is that the "old days" will return to the mining camps. Prohibition would probably not have much effect in this country except on the white population, and it would be salvation of some of it.

We have not been troubled much with drunkenness among our native workmen. Many of them drink tuba, but it seems to have little bad effects. I had one section foreman who got a "tuba jag" every night, but he never lost one day's work in more than two years. As a rule natives drink tuba only in the evening, and they have a chance to sleep off the effects before morning. It is so cheap that what is spent for it seldom impoverishes the family. Since American occupation some of the better class of natives have become addicted to alcohol, more the result of association than the inherent desire of the Oriental for strong drink.

Cebu, Philippine Islands. J. CLAYTON NICHOLS.

Petrology, Geology, and Good Roads

THE EDITOR:

Sir—One of the most important undertakings in this country today is the building of highways; the value of each piece of road is based upon the service it will give, and that depends upon the intrinsic worth of the material used, and upon the intelligence, capability, and integrity of the engineer directly in charge. I have come in contact with road engineers who have wasted large amounts of money as a consequence of their lack of knowledge of the intrinsic worth of the material entering into road construction. I have found engineers directing road building who were entirely ignorant of the nature of stone, sand, and gravel. They did not know the difference in the burden-bearing strength of various rocks, their hardness, resistance against trituration, or weathering qualities under varying conditions. Although shale under some circumstances might be cheaper in the end than better stone, they apparently had no means of knowing its value other than by use; they did not know that far better rock was accessible at even less cost. They did not know from appearance the difference between quartz and epidote, they could not distinguish between quartz and chert and flint; they did know that sand was sand, whether or not it was contaminated by mica, fragments of shells, particles of coal, nodules of iron oxide, or even vegetable organic matter—or if they did know better they permitted the use of inferior material.

I believe that no road engineer is fit until he has mastered the sciences of petrology and geology, not only theoretically but practically, for until he has, he is incapable of avoiding the expensive errors which are being committed every day. As is too well known for discussion, the value of concrete depends in a large measure on the aggregate; no capable petrologist but knows that some rocks decay almost as rapidly as some wood. If we are to have good roads we must put good material into them; and the competent road engineer must study the rock that is available for his work.

Elizabethton, Tenn. HENRY V. MAXWELL.

The Tariff on Minerals

THE EDITOR:

Sir—In the very interesting Annual Review Number of the *Engineering and Mining Journal-Press* of Jan. 20 appeared an article on "The Tariff on Minerals," signed by Marc Pawl. This article referred, among other features of the Fordney-McCumber Act, to the tariff on antimony products and made a number of statements of fact (sic) which were inaccurate and which I feel were sufficiently important to call for correction.

Mr. Pawl was quite correct in stating that no tariff was placed on antimony ore and that imported metal was taxed at 2c. per lb. He was incorrect in saying that "an American representative of a Chinese firm immediately went to Washington and advised the committee that a tariff should be put on needle antimony but that none should be put on the oxide." The only representative of a Chinese firm who appeared in Washington in connection with the antimony tariff was G. C. Riddell, secretary of the Wah Chang Trading Corporation, with which I am also connected. Mr. Riddell at no time made any protest against either the proposed tax on the metal (1½c. at that time) or on the oxide (2c. per lb.), but he did urge that needle (crude) antimony should not be placed on the free list as proposed (being a partially manufactured commodity, dutiable at 10 per cent ad valorem, under the then effective Underwood Act), but should enter under a compensatory rate, ½c. per lb. below the duty on regulus or metal. The record of Mr. Riddell's testimony is to be found in the tariff hearings before the Committee on Finance of Aug. 8 and Dec. 28, 1921.

The rate finally adopted for needle antimony and now in the act was ½c. per lb., *not* ¾c., as stated by Mr. Pawl. See Tariff Act, 1922, Paragraph 376.

It is too bad that Mr. Pawl did not also have more accurate information from China to incorporate in his

article. For the greater part of 1922 the production of antimony in China was greatly reduced, being estimated at an average of from 700 to 800 tons monthly, of which about 600 tons was metal (regulus), 100 tons needle (crude), and only 100 tons oxide. Any exports from China in excess of these approximate tonnages were undoubtedly from accumulated old stocks. The "largest antimony mines in China" were emphatically *not* "turning all their product into oxide."

It is true that "a tariff was placed on the raw material" (crude needle, ¼c. per lb.), but also true that the "competing product" (oxide) was taxed 2c. per lb.—a very good measure of protection for the American manufacturer.

Mr. Pawl might with advantage to himself have familiarized himself with the act before writing his article. He goes on to compare the price for needle antimony c.i.f., New York, which he states has been, since the passage of the Fordney-McCumber Act, 4⅛c. to 4¼c. per lb., with the price of Chinese oxide at 4¼c., c.i.f. New York. On this basis, oxide entered for consumption would cost 6¼c. duty paid, and needle (crude) on the same basis 4⅜c. to 4½c.—a difference of nearly 2c. per lb. These prices refer of course to import lots, usually a twenty-five-ton minimum. The price of 2¼c. c.i.f. New York, for needle, to which Mr. Pawl refers earlier in his article, was practically the lowest price for all time at which this commodity ever sold and was over 1c. below the average over any term of years.

In another paragraph of Mr. Pawl's article he says "apparently no Senator thought of looking into the report to see whether the statements made were true." This remark calls forcibly to mind the old saying about those who live in glass houses throwing stones.

New York. H. K. MASTERS.

The Iniquity of Unequal Pay

THE EDITOR:

Sir—In the Sept. 2 issue you had an editorial entitled "Does Mining Require More Skill Than Shoveling?" In other words, should the miner receive more pay than the mucker? I would like to call attention to an aspect of this question that is seldom looked into—namely, the interdependence of all work or service. The following experience will illustrate how the failure to appreciate this interdependence may lead to great losses. It will also show that the present ways of compensating work are of very doubtful value:

A smelter I worked in a number of years ago was in a very bad way. It wasn't paying; so a man was sent from New York to straighten things out. One of the first things he did was to lay off all labor he did not think essential to the efficient working of the plant. Some were men employed to shovel down ore in the bins—screenings that went to the roasters. The reason shovelers were needed for this was that the bins had flat bottoms—some of the bottoms were below the chute door. Shortly after this, the roaster and the reverberatory furnace shut down, and the screenings accumulated in the bins. The summer rains fell on them (the bins were not covered), which caused them to become cemented. It was found, when the roasters and reverberatory started up again, that, on account of not having enough shovelers, more were needed than ever, because of the screenings being cemented. Only three charges to a shift of eight hours could be delivered to the roasters, where formerly eight were delivered, eight being the capacity of the roasters. One can figure the loss this meant. In order to save $5 or $10 on shovelers they lost at least $200 or $300. It meant a decrease in the efficiency of the reverberatory furnace of more than one-half.

The point is this: a slight failure at any point in an industrial plant, no matter how caused, or how insignificant that point may appear to be, is capable of causing great losses. It is this more than anything else that should determine a man's pay. It is the relative value of men's services that should determine their relative wages. The interdependence of all service in the production of a thing makes all service equally valuable. Therefore, all service should receive the same pay.

This will shock some. They shouldn't be. They will say, "What! do you think unskilled work should be paid as much as skilled work?" There is no such thing as skilled work and unskilled work: all work if done right requires equal skill. There are skilled and unskilled workers, perhaps, but there need not be; they are the product of the idea that there is skilled work and unskilled work; they are the product of unequal pay. This needs explaining. The following incident will illustrate the point on which the claim is made that one job requires about as much brains and skill as another, and is about as important: A man came into a repair shop one day and asked a man filing on something at a vise if he had his key ready. "Yes," replied the man at the vise; but instead of giving the man his key then he kept on filing for about five minutes. He wasted five minutes of the man's time without gaining a single second for himself. Go into a store some morning when the clerk is sweeping out. Many a clerk will keep on sweeping after you enter. He wastes your time, but gains nothing. There isn't a job of any kind that does not require considerable thought and prompt action to avoid wasting some one's time, often the time of many. Take, for instance, a ticket seller at a theater. Every moment he delays he wastes as many moments as there are people in line. If a man buying a ticket hasn't his money ready he delays everybody in the line. Apply this to conditions in a mine. Take the trammer and top man, for instance, two men who receive less pay than any working in a mine. These are in a position where if they don't use their heads and act promptly they will waste more of the time of the men working in the mine than any man in it. Their work, if done right, requires just as much brains and skill as any work in the mine. The management by not paying better wages to these men in order to get this work done as it should be done saves cents and loses dollars.

Unequal pay doesn't make for more skill in either the so-called skilled or unskilled workers. If one job pays more than another, immediately some men will start monopolizing it. The most skillful at monopolizing a job are generally not the most skillful at it. The greater pay is an incentive to monopolize a job by unionizing it. The only way to destroy the unions is to give all workers equal pay. This would destroy the incentive to form unions. If the job pays less than others no one stays with it, if he can help it. As the job pays less than any other, there is no competition or incentive to learn anything about it. Consequently, no one ever learns the possibilities of it. No one wants to know, for what good would it do; there wouldn't be any money in it. There is no better device for destroying efficiency and skill than unequal pay.

We hear a great deal of talk about square plugs being

in round holes. Unequal pay is the cause of it. Unequal pay puts a premium on something else than the ability to do some certain thing well. Equal pay would put the round plugs in the round holes.

Unequal pay is a time waster. Where there is an interdependence of jobs, all men's time is equally valuable. WILLIAM CROCKER.

Prescott, Ariz.

Religion and Science

THE EDITOR:

Sir—In view of the recent discussions concerning science and religion in your columns, it may be of interest to geologists and mining men to learn that the so-called science of geology is all a mistake. At least, so we are assured by a professor of geology who has written half a dozen books to prove it. Apparently there is nothing for mining and oil companies to do but to discharge their geological staffs and invest in doodlebugs instead.

According to this learned professor, George McCready Price, who holds the chair of geology at a small denominational college in Nebraska, all geologists, excepting of course himself, are sadly deluded about their science. They talk about Cambrian trilobites, Mesozoic reptiles, and Tertiary mammals as though these various animals really lived at different times, and they write books and papers in which such "tommy-rot" as paleogeography, diastrophism, migration of faunas, and similar expressions, "insult the reader on every page." Professor Price's new textbook (900 p., 600 illustrations) is destined to purge geological science of all such absurdities. The author has demonstrated to his complete satisfaction that dinosaurs and trilobites, ostracoderms and ammonites, graptolites and saber-tooth tigers were all contemporaneous, and were buried in the rocks by the self-same deluge that floated Noah's ark. We are not informed why Noah did not take a pair of brontosauri, two pterodactyls, and a male and female plesiosaur into the ark along with his cargo of elephants, fleas and boll weevils, but such questions are doubtless outside the realm of the new and purified Pricean geology.

Mining geologists will be glad to learn from the professor that overturned folds and thrust faults are a figment of the imagination, and that geological chronology and stratigraphy based on it are merely delusions. This will doubtless greatly simplify the matter of apex litigation, which will be hard on the lawyers, so Professor Price need expect no support from them when he tries to put through his bill making belief in evolution punishable by penal servitude for life.

We are not informed what is to be done with the U. S. Geological Survey, but perhaps its research capacity can be employed for the purpose of ascertaining whether Adam was created at 9 a. m. on October 26, 4004 B. C., or at 9.30. William Jennings Bryan will doubtless be appointed chief theologist of the reorganized survey. Some concessions will probably have to be made to the ancient traditions of geology. For example, it may be necessary to permit the continuance of the heresy of the chronological relation of strata in order to locate coal beds and oil sands, though more probably coal and oil will be declared immoral anyway.

But why should anybody want to study geology at all, when he can write textbooks and be a professor without going to so much trouble? It's much more profitable to be clever than wise, and if you play to the gallery you become a popular lecturer and boost your bank account. But if you are a scientist and a scholar—well, nobody listens to you anyway, except other scientists, and all scientists are queer. Yes, they are—they think.

Bryn Mawr, Pa. MALCOLM H. BISSELL.

The Other Side to a Controversy

THE EDITOR:

Sir—Your issue of Jan. 27, 1923, on page 201, contains an article by W. H. Staver concerning the Sunnyside mine, at Eureka, Col. I see a more or less veiled propaganda in spite of his qualifying remark, "In these pussyfoot days some plain words without any camouflage may help." In my opinion he exaggerates the past and present possibilities of the mine in such a way as to throw undue credit on the former owner and manager, while at the same time questioning the wisdom of dispensing with the experience and advice of Joe Terry, and implying a doubt that the present manager, E. L. Young, possesses the experience or ability to direct the operations at the Sunnyside mine to a successful conclusion.

The past record of successes obtained at the Sunnyside under the Terry management is amply punctuated by numerous failures. Conspicuously among these stands the Terry tunnel, which, to say the least, was ill advised. The oreshoots in the Sunnyside veins proper, as well as in the Noname and Washington veins, have bottomed well above the elevation of the Terry tunnel level. Granting that the oreshoot now being worked in the Washington, which is undoubtedly the strongest ore channel existing in the property, shall continue in pay ore to the Terry tunnel level, or had been known beforehand to have done so, still the Terry tunnel has nothing to justify its existence, not even for drainage.

At the time the present company took over the Sunnyside, the mine had its eyes picked out, the development had followed the lines of least resistance, and in such an awkward way as to be useless; it was adorned with such a number of blunders in the way of improperly designed and misplaced surface equipment as to make economical production almost hopeless.

The mill is a credit to the present company, modern and second to none in the state. The design of the mill and the flow sheet are due to the efforts of the present operators in solving as complicated a metallurgical problem as is to be found.

The "Swede-Finn" never has been a problem, and upon investigation it will be found that the present manager has had a long and successful experience with the "Austrian-Italian," more so than any other operator in the San Juan, present or past. A local coterie, mostly of Celtic origin and with I.W.W. proclivities, has sorely tried Mr. Young, who has, however, demonstrated his ability to manage them.

It will not be snow slides, inefficient and delayed railroad service, or the labor situation which will prevent E. L. Young, backed by a liberal and courageous mining corporation, the U. S. S. R. & M. Co., from putting the operations at the Sunnyside mine on a profitable basis; but the fact that well-directed and liberal development has not, and the continuation may not, disclose sufficient ore in the old hole. It will require a tonnage vastly in excess of 600,000-odd tons of the type of ore now found to make a mine out of the Sunnyside.

Leadville, Colo. GEORGE E. BOWEN.

[Editor's Note: Both sides of this "controversy" have been aired in these columns and we cannot publish anything further on the subject.]

The New Concentrator of the Real Compania Asturiana de Minas, Spain

Tabling and Flotation Treatment Provided for in New Plant Treating Zinc-Lead Ore—Under Existing Conditions Finer Grinding in Ball Mills Is Secured by Increasing Pulp Dilution

By Leopoldo Barcena y Diaz
Metallurgical Engineer, Royal Asturiana Mining Co.
Translated by W. A. Butchart

Leopoldo Barcena y Diaz

In July, 1919, I published in *Ingeniería* (Madrid, Spain), three articles which formed a résumé of the work in which I had been engaged in the laboratory of the Reocin Mines looking to the application of the flotation process to the treatment of the ores of the Real Compania Asturiana de Minas (Royal Asturiana Mining Co.). Three years have passed. The results obtained in the small experimental plant were so satisfactory that the management authorized the construction of the present plant, which was put in operation a few months ago with results fully as satisfactory as had been anticipated.

The experimental installation had a capacity of sixty tons per twenty-four hours. The ore arrived at the plant ground to —1.5 in. The mineral composition was: Zinc blende, 15 to 30 per cent; calamine, 1 to 4 per cent; galena, 1 to 7 per cent; and iron, 3 to 7 per cent, as oxides and sulphides. The gangue was dolomite with practically no silica.

The three-ton cars were dumped in a hopper, an automatic feeder supplying the 4.9 ft. conical mill which worked in closed circuit with a drag classifier 27½ in. wide. The classifier overflow formed the feed of the flotation machine, which was of the mechanical agitation type. This machine had twelve agitation and eleven frothing compartments. The agitators were 12 in. in diameter and made 500 r.p.m., using 17 hp.

The first seven frothing compartments made concentrate, which was treated on a Humboldt table to remove galena, which went to a bin, the zinc going to a 20 ft. thickening tank. The thickened concentrate, containing 65 per cent solids, was stored in tanks, where it was air dried to 15 per cent moisture. The remaining four frothing compartments made middling, which was retreated in the same machine. The last frothing compartment made tailing, which passed through a spitzkasten, where it was dewatered and again put over the Humboldt table. This table served principally as a pilot from which the work of the flotation machine might be known at any moment, although it also separated some calamine which this ore always carries.

The tailing from this table went to a sand pump, and thence to the spitzkasten, where the sand was separated and sent, by cars, to the tailing pile, the slime going to settling tanks.

Grinding in the Experimental Plant

Regrinding the ore to flotation size was done in a home-made conical mill, 4.9 ft. in diameter, the iron liners being 2 in. thick. From experiments made by varying single factors which could influence grinding the following conclusions were reached:

Speed.—At 34 r.p.m. the mill required 40 hp., and at 30 r.p.m. the consumption dropped to 32 hp. As the decrease in speed produced no appreciable difference in the quality of the work with a load of sixty tons per twenty-four hours, this rate was adopted.

Capacity.—Maintaining in the mill a pulp containing 70 per cent solids, ore containing 22 per cent zinc gave the following results:

Screen Analysis

Size	Feed, Per Cent by Weight	Product, at 45 Tons per 24-Hr., Per Cent	Product, at 65 Tons per 24-Hr., Per Cent	Size	Classifier Overflow 22 Per Cent Solids: 45 Tons per 24-Hr., Per Cent	Classifier Overflow 22 Per Cent Solids: 65 Tons per 24-Hr., Per Cent
+ 2 in.	0	..	..	.....	....	....
+ 0.6 in.	23	..	..	.....	....	....
+ 0.4 in.	33	..	..	.....	....	....
+ 0.08 in. (2 mm.)	..	1	9	.....	....	....
+ 0.04 in. (1 mm.)	..	5	4	.....	....	....
+ 40 mesh	30	5	5	+55 mesh	0.2	0.8
+ 100 mesh	5	31	32	+ 100 mesh	3	12
+ 200 mesh	5	30	25	+ 200 mesh	33	33
—200 mesh	4	28	26	— 200 mesh	63	55

The screen analysis of the classifier product is given, as it was the feed to the flotation machine. Above the rate of sixty-five tons per twenty-four hours, the oversize increased considerably.

Ball Charge.—Operating on a lot of ore similar to that shown in the last table, but with 15 per cent zinc, and keeping the pulp in the mill at 70 per cent solids, the following results were obtained:

Screen Analysis

Size	Using 3.5 Tons Balls, Per Cent	Using 2 Tons Balls, Per Cent
+ 2 mm.	2	1
+ 1	5	6
+ 40 mesh	7	10
+ 100 mesh	38	44
+ 200 mesh	27	22
—200 mesh	21	17

With three and one-half tons of balls the mill required 32 hp.; with two tons of balls the consumption was 24 hp.

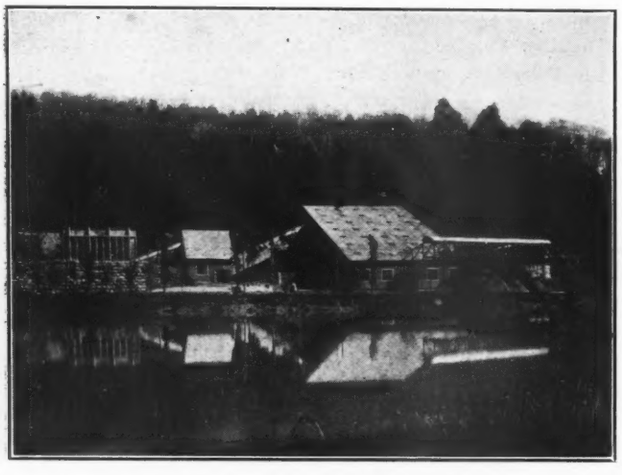
Pulp Dilution.—From the beginning of the study of grinding, it was noticed that *a dilute pulp gave a finer product than one containing a greater quantity of solids.* A test was made in the treatment of the lot of ore last mentioned, with two tons of balls in the mill and at the

rate of fifty tons per twenty-four hours, with the following results:

Screen Analysis

Size	Pulp, 70 Per Cent Solids	Pulp, 50 Per Cent Solids
+ 2 mm.	1	Trace
+ 1 mm.	6	3
+ 40 mesh	10	5
+ 100 mesh	44	39
+ 200 mesh	22	26
— 200 mesh	17	28

Other tests were made in which the mineral content of the ore varied, and consequently its hardness, using various charges of balls, with similar results. And today, after six months of actual mill work and with two 6-ft. Hardinge mills in operation, the most certain means of reducing oversize is to increase the dilution. This is of considerable interest, as it signifies that if it is desired to obtain a granular product for table treatment, it is necessary to maintain an especially thick pulp in the mill, and if it is desired to produce a large proportion of —200 mesh, dilution must be effected. This seems entirely contrary to what has been written by



General view of the Reocin plant

those who have made studies of grinding and even by the manufacturers of grinding mills.

Algernon del Mar says, in the first edition of his work "Tube Milling," p. 45, that "if it is desired to obtain a granular product, more water is required than for the production of fines." It is true he speaks of a certain Hardinge mill installation treating a pulp containing 3 parts of water to 1 of solids, but this he appears to consider as wrong and clings firmly to the principle of "more water, coarser discharge." It may be said, of course, the results on the ore at the Royal Asturiana property are unusual. However, they appear logical to me, and it seems that, for the following reasons, the same results should be secured on all ores.

In a dilute pulp of 30 per cent solids, for example, the coarse, heavy grains settle rapidly, the fine, light particles slowly, with the result that the former are at the bottom and the latter at the top of the pulp in the mill. In a pulp of 70 per cent solids this effect is not so evident, and at all levels of the pulp will be found both coarse, heavy, and fine, light grains. Now imagine a central-discharge ball mill treating a dilute pulp. The water tends to carry the fine as well as the coarse grains toward the point of discharge. The first are easily carried, but not the second, for because of the dilution of the pulp they tend to settle or occupy the zones of greater diameter in the mill where the grinding action is greatest. In fact, the mill tends to act as a classifier, retaining the coarse, heavy grains and allowing the overflow of fine. If the mill is working upon a thick pulp, it is natural that none of the effects just mentioned should be produced, and that the discharge should contain grains of all sizes.

Another important fact which may be noted in the assays of the various products from screen sizing an exceptionally thick pulp is that there will be very little difference in the grade of the —100 mesh and the +100 mesh, as may be seen from the chemical and screen analyses of the product of the 6-ft. x 22-in. Hardinge mill in the present Asturiana plant. It was this result which caused us to prefer the simple Hardinge mill for grinding our ore to 2 mm. rather than a mill having a grate discharge, which at first view seemed indicated if it is desired to concentrate primarily by means of shaking tables.

What would happen if we should continue decreasing or increasing the quantity of water in the mill feed? The first has been tried. The power consumption of the mill begins to fall, it becomes less noisy, and the discharge becomes continuously coarser, until the mill finally fills with ore and no grinding occurs. With the second condition I have experimented only to dilutions of 20 per cent solids and have always found finer grinding with more water. It is clear that this will reach its limit, beyond which the discharge will again increase in coarseness.

Summary of Desirable Operating Conditions

If the least possible quantity of fines is desired, it is necessary:

1. To maintain a thick pulp.
2. To have a small charge of balls in the mill.
3. To treat the greatest tonnage possible.

This was of great importance in our case, as the flow sheet for the final installation at Reocin would necessarily include:

1. Grinding to 1, 2, or 3 mm.
2. Taking out on roughing tables the greatest possible quantity of concentrate.
3. Grinding the middling to 60 mesh, and
4. Floating.

The second feature required grinding with the production of the least possible quantity of —100 mesh.

Proper Classification a Hard Problem

As mentioned later in the description of the plant, the ball mill worked in closed circuit with a drag classifier. The latter was of the helical type, 24 in. in diameter and made 30 r.p.m. The slope upon which it worked was generally 25 per cent. Under these conditions its work was as follows:

Classifier Screen Tests

Size	Feed 23 Per Cent Solids, Per Cent	Overflow, Per Cent
+ 2 mm.	0.60	.....
+ 1 mm.	3.4	.....
+ 55 mesh	27.5	3.04
+ 100 mesh	27.0	14.48
— 100 mesh	41.5	83.48

The oversize carried 30 per cent of —55-mesh material, and although many tests of the classifier were made with changes in grade, speed, and pulp dilution, this proportion of fines in the discharge sand remained constant.

The specific gravity of the Asturiana ores is from 3.0 to 3.5, and for such heavy ores the standard types

of classifiers, such as the Akins and Dorr, are not suitable, because if they are required to treat a determined tonnage of sand the bowl contains an excessive quantity of water, which produces too fine an overflow. If the water reservoir is of suitable capacity so that the overflow may be of the desired coarseness, the rakes have not sufficient capacity to handle the sand.

There has been recently installed at mines near Reocin a 36-in. Dorr classifier, and to make it overflow 50-mesh material it has been necessary to lower the level of the overflow 12 in. and increase the speed to 30 strokes per minute.

An Akins classifier, to work well with these ores, must be relatively small and the speed of the helix double or triple the standard rate. The mechanical classifiers of the helical type, such as the Akins, are the most simple, but these, as well as the Dorr apparatus, we found to do imperfect work, for they return to the mill a large proportion of material already sufficiently fine. It appears the reason for their extensive use is the convenience which results from installing an apparatus which, while "fool proof," performs three operations: classification, elevation, and transport of sand to the ball-mill feed entrance.

Determining the Best Flotation Oils

The flotative agents at our disposal when the plant went into operation were coal-tar creosote, cresol, sulphuric acid, and copper sulphate. Laboratory investigations had shown that steam-distilled pine oils, or those obtained by distilling crude pine tar at 220 deg., were superior to cresol, principally because they greatly reduced the acid consumption, but neither of these was available, and it was necessary to use cresol.

The first step was to find the quantity and proportions of these agents that would float the greatest possible quantity of zinc blende, the tailing re-treatment table serving as an indicator on this point. After several weeks of experimental work, it was found that the best mixture per ton of feed was: Creosote, 2.2 to 5.5 lb.; cresol, 0.44 lb.; sulphuric acid, 8.8 lb.; and copper sulphate, 1.1 lb., added in the form of a 20 per cent solution. From this mixture the following results were obtained:

Experimental Flotation Results

	Per Cent Zinc	Per Cent Lead
Feed	10 to 22	3
Zinc concentrate	53	2
Lead concentrate	1	75
Tailing	1 to 4	Trace

This variation in the grade of the tailing is due to the fact that the Reocin mines are being worked in the upper levels where the blende is sometimes oxidized or contain oxides, carbonate, or silicate of zinc. The consumption of flotative agents seemed high, and a method of decreasing the quantities was sought.

After several months of testing, two pine oils were received, G. N. S. No. 5, a steam-distilled pine oil, the other marked T. D. A., obtained by fractional distillation. The first gave most excellent results, for, with a consumption of 0.18 lb. per ton of ore the use of acid was stopped entirely, and the copper sulphate was reduced to 0.66 lb. per ton. The second oil also permitted omitting the use of acid, but produced a low-grade concentrate and a permanent froth. Tests were also made of G. N. S. No. 8, which contained much pine tar and which flooded the plant with froth. The concentrate carried 40 per cent zinc, and the tailings, 0.80 per cent zinc. Crude petroleum was tried without success. Finally, the best mixture was determined to be, per ton of oil: Creosote, 2.2 to 4.4 lb.; G. N. S. No. 5, 0.18 lb.; copper sulphate, 0.66 lb.

At first the creosote was fed into the ball mill. Experiments were then made by adding it to the first agitation compartment of the flotation machine. Not only was no advantage found in introducing it into the ball mill, but when introduced in the flotation machine the froth was more heavily mineralized and less voluminous, the recoveries remaining equal. Neither was any advantage found in adding oil at various compartments.

The consumption of creosote varied considerably with the grade of ore treated. With 10 per cent zinc, the consumption was about 2.2 lb. per ton, and 4.4 lb. on ores containing 20 per cent zinc. These high creosote consumptions may attract attention, for generally 2.2 lb. is sufficient. It must be noted that the ores of this region cannot be considered easily floatable.

Although it had been our intention to experiment with other flotation machines, such as those employing pneumatic agitation, this was not done, because of a conviction that it would be impossible to improve the results obtained in those using mechanical agitation. Moreover, the power economy which it is said has been obtained with the pneumatic machines does not appear certain, for with our apparatus we were able to treat up to seventy tons per twenty-four hours with 17 hp., whereas a manufacturer of pneumatic cells indicated 20 hp. for fifty tons per twenty-four hours.

Flow Sheet of the Present Plant

In determining the flow sheet of the new plant the question was whether to grind to 2 mm., concentrating by gravity and flotation, or to 48 mesh, using flotation only, as in the experimental plant. The first method has the following advantages:

1. As the ores contained from 1 to 7 per cent lead, and differential flotation was not developed to the necessary degree of perfection, a greater recovery of lead could be obtained than by grinding to 48 mesh.
2. Gravity concentration would produce a certain tonnage of zinc concentrate on which flotation royalty would not have to be paid.
3. The recovery would be higher, particularly when the mill feed contained oxides or carbonates.

Its disadvantages are:

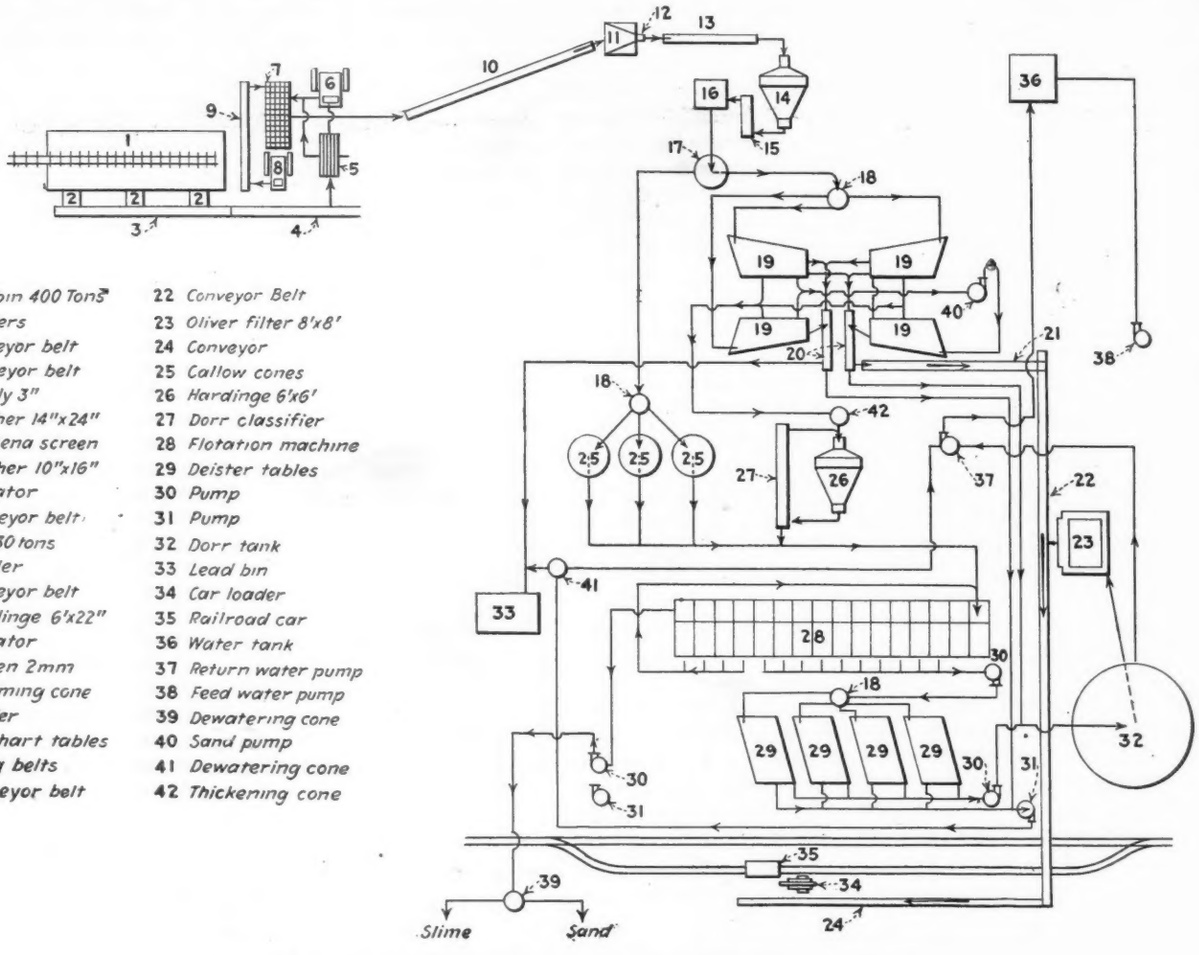
1. As these ores always contain iron pyrite, the gravity concentrate would always be lower in zinc than that produced by flotation; therefore, the average grade of the plant product would always be lower than that of the all-flotation plant.
2. The installation must be more complicated and therefore more expensive.

Considering the first objection as not serious, for, although the concentrates may contain less zinc they will carry more sulphur, and that the second is compensated in part by lower operating costs, it was decided to employ a combination of gravity concentration and flotation as shown in the accompanying flow sheet.

Description of the Plant

The ore, in pieces less than 16 in., is dumped into the 400-ton reinforced concrete storage bin, (1) which is provided with three gates 24 x 24 in., each having its steel apron feeder (2) 29½ in. wide. These are operated singly, and when one can discharge no more ore another goes into service, thus insuring the complete emptying of the bin and therefore continuous service. The feeders have a speed of 20 in. per minute, discharging

twenty-five tons of ore per hour. They discharge upon a conveyor belt (3) 27½ in. wide, which leads to another (4) of the same size but having an incline of 20 deg. This carries the ore to the crushing plant, consisting first, of a grizzly (5), which separates the +3-in. material which goes to the 14 x 24 in. jaw crusher (6), the —3 in. and the crusher product going to the Barcena shaking screen (7) fitted with 1½-in. round-opening perforated plate. The +1½ in. ore goes to the crusher (8), having a jaw opening 10 x 16 in., whose product is returned to the screen (7) by the bucket elevator (9).



1 Ore bin 400 Tons
2 Feeders
3 Conveyor belt
4 Conveyor belt
5 Grizzly 3"
6 Crusher 14"x24"
7 Barcena screen
8 Crusher 10"x16"
9 Elevator
10 Conveyor belt
11 Bin 30 tons
12 Feeder
13 Conveyor belt
14 Hardinge 6'x22"
15 Elevator
16 Screen 2mm
17 Desliming cone
18 Feeder
19 Butchart tables
20 Drag belts
21 Conveyor belt
22 Conveyor Belt
23 Oliver filter 8'x8'
24 Conveyor
25 Callow cones
26 Hardinge 6'x6'
27 Dorr classifier
28 Flotation machine
29 Deister tables
30 Pump
31 Pump
32 Dorr tank
33 Lead bin
34 Car loader
35 Railroad car
36 Water tank
37 Return water pump
38 Feed water pump
39 Dewatering cone
40 Sand pump
41 Dewatering cone
42 Thickening cone

Flow sheet of new mill of Real Compania Asturiana de Minas

The —1½-in. ore is carried to the concentrating plant by the belt (10), 20 in. wide on 108-ft. centers, working at an angle of 21 deg. Here the ore is ground to 2 mm., and passed over tables, which recover approximately 50 per cent of the lead and 40 per cent of the zinc, the reject being reground to 80 mesh and treated by flotation.

The ore is received at the grinding plant in a steel hopper (11) of thirty tons' capacity, an automatic sampler cutting out one ton from each 2,000 treated. The hopper is provided with an 18-in. steel apron feeder, traveling 4 ft. per minute, which discharges the ore upon the 20-in. conveyor belt (13) by which it is carried to the 6-ft.x22-in. Hardinge mill (14). This mill is loaded with five tons of steel balls, has a speed of 27 r.p.m. and requires 45 hp. It works in closed circuit with a guard screen (16) of 2-mm. opening wire cloth. The 2-mm. product passes to the 48-in. desliming cone (17), where all —150-mesh material is removed, the spigot discharge going to an automatic distributor and thence to three Butchart tables. The zinc-dolomite middling from these three tables is elevated by a centrifugal pump to the fourth Butchart table, the entire surface of which is riffled.

The galena produced by these tables goes to a drag belt (20) and then to the car. The zinc goes to the zinc drag belt, from it to the 12-in. conveyor belt (21) and to an automatic sampler. These drag belts reduce the moisture of the lead and zinc to 15 per cent, the excess water going to the corresponding pumps of the lead and zinc flotation plants for the recovery of any sulphides in suspension.

The middling produced by these four tables goes to a 36-in. cone, where a large amount of clear water is removed and returned to the circuit. The spigot discharge, containing 50 per cent solids, goes to the second Hardinge mill, 6 ft. x 16 in., with a charge of 4.5 tons of 2-in. steel balls. It requires 38 hp. and works in closed circuit with a 36-in. Dorr classifier making 28 r.p.m.

The — 50-mesh slime separated by the cone (17) is thickened in three Callow cones (25), 9.5 ft. in diameter, which produce a clear water overflow, returned to the circuit, and pulp containing 25 per cent solids, which joins the overflow of the Dorr classifier containing the same percentage, both products going to flotation.

Flotation is accomplished in a standard 18-in. M. S.

machine having sixteen agitating and fourteen frothing cells. The flotative agents used per ton are 3.3 lb. coal-tar creosote (anthracene), sometimes 0.13 lb. of G. N. S. No. 5 oil, and 0.66 lb. copper sulphate,

The froth from the first ten cells is a finished product, which goes to an automatic distributor and thence to four Deister slime tables for lead-zinc separation. The froth from the remaining four cells is returned to the machine and is again put through with the original feed. The last frothing cell makes tailing, which is elevated by a pump (30), sampled automatically, and carried to a cone (39) placed near the tailing piles. This cone is 72 in. in diameter, and separates sand, which is carried by car to the nearest tailing pile and dumped, a slime product which goes to a series of settling tanks about 500 meters distant.

The galena separated by the four Deister tables goes to a pump (31), which elevates it to a cone (41), 31 in. in diameter, overflowing clear water to the circuit and producing galena with 25 per cent moisture, which goes to the lead-concentrate bin, which also receives the product of the drag belt (20).

The blende is lifted by a pump (30) to a Dorr tank (32) of reinforced concrete, 47 ft. in diameter, passing first through an automatic sampler. The rakes in the Dorr thickener make one revolution in six minutes; clear water overflows to the circuit, the underflow, containing 65 per cent solids, being sent through a No. 4 Dorrco pump to an Oliver filter (23) 8 x 8 ft. The filter operates ten hours to each twenty-four working hours of the rest of the plant, and produces a zinc cake containing 10 to 12 per cent moisture, which falls upon a 14-in. conveyor belt (22), 197 ft. between centers, which carries also the blende from the Butchart tables. The filter tank has a discharge connected with the pump (30). This conveyor belt discharges into a drag (24), 8 in. wide, which piles the blende in a heap 100 ft. long by 40 ft. wide, whence it is placed in railroad cars (35) by a Barber-Greene automatic loader (34).

The crusher plant has a capacity of 800 tons and the concentrator 200 tons per twenty-four hours. All pumps are installed in duplicate. The power consumption is 180 hp. in the concentrator and 20 hp. in the crusher plant, or about 1 hp. per ton of feed. Power is purchased from the Viesgo Electric Co. as 3-phase, 50-cycle, 12,000-volt current, which is transformed to 200 volts. Six men per shift operate the plant. The water consumption is 234 gal. per minute.

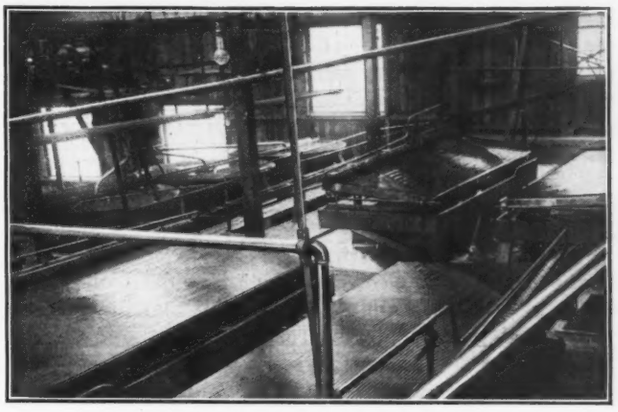
Grinding-Mill Tonnage Increased by Altering Design of Feeder

Below will be found tonnages per twenty-four hours as well as chemical and screen analyses of the ore arriving at the concentrating plant. The ore from the crusher plant, constituting the feed of the 6 ft. x 22 in. Hardinge mill, has the following sizes:

	Per Cent		Per Cent
—1.5 in.	100	0.08 in.	30
+1 in.	30	—0.08 in.	12
+0.375 in.	28		

Grinding 200 tons per twenty-four hours of an ore containing 26.2 per cent zinc, and with 40 per cent moisture in the mill, the 2-mm. screen (16) gives an undersize as follows:

Size	Per Cent by Weight	Per Cent Zinc	Size	Per Cent by Weight	Per Cent Zinc
+ 1 mm.	10	18.97	+ 150 mesh	12	25.51
+ 40 mesh	14	23.33	+ 200 mesh	6	25.72
+ 100 mesh	34	25.07	— 200 mesh	22	23.98



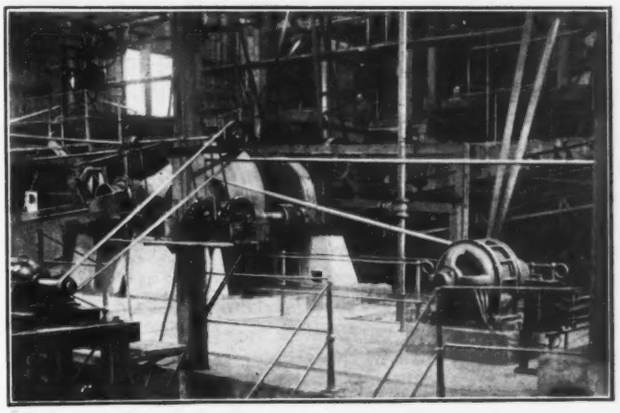
Concentrating tables in new plant

The oversize of this screen amounts to thirty tons per twenty-four hours, and contains 20 per cent of —2-mm. sand. As is natural, when the ore is low grade the amount of oversize increases greatly, and at times we are forced to dilute the pulp in the ball mill to reduce the quantity. If the ore does not carry 15 per cent zinc it is difficult to put through 200 tons in twenty-four hours.

Certain modifications were made in the Hardinge mill to enable it to treat 200 tons per twenty-four hours of our ore ground to 1½ in. The interior diameter of the scoop through which the ore passes to the conical connection and thence through the throat was 7 in. in the mill as received, and the smallest section of the scoop 5½ x 6 in. Feeding the mill with our ore ground to 1½ in., the scoop would handle only 175 tons per twenty-four hours and only 155 tons of +⅜-in. to —1½-in. ore. The scoop stuck whenever an attempt was made to treat heavier tonnages. Following the manufacturer's instructions, the speed was increased, the mill was given a slope of 1 per cent toward the discharge, and a deflector plate was placed in the scoop to make the feed enter the mill more rapidly, but without improvement. This demonstrated that the defects were:

1. In the narrow 5½ x 6-in. section of the scoop, and
2. In the small diameter of its central portion.

We succeeded in increasing the capacity of the scoop to 200 tons per twenty-four hours by modifying this part of the mill. The conical-shaped piece was changed to a cylindrical, a helix of 10-in. pitch was placed in the throat, the constricted section of the scoop eliminated and its central diameter increased from 7 to 9 in. The



Grinding floor, showing primary mill

result of these changes has been the addition of fifty tons to the capacity.

The desliming cone separates 135 tons per twenty-four hours of sand with 68 per cent moisture, which is the feed of the Butchart tables, the screen and chemical analyses being as follows:

Size	Per Cent by Weight	Per Cent Zinc	Size	Per Cent by Weight	Per Cent Zinc
+ 1 mm.	19	17.22	+ 150 mesh	12	29.21
+ 40 mesh	17	22.02	+ 200 mesh	5	34.23
+ 100 mesh	45	27.69	— 200 mesh	2	25.21

The cone overflow consists of 65 tons per twenty-four hours of slime containing 85 per cent moisture, screen sizing giving the following results:

	Per Cent		Per Cent
+ 100 mesh	0.15	+ 200 mesh	13
+ 150 mesh	3	— 200 mesh	83

The thickened pulp discharged by the three cones contains 25 per cent solids.

The 6-ft. x 16-in. Hardinge mill grinds a pulp containing 50 per cent solids and the overflow of its classifier carries 25 per cent solids and 2 per cent +72 mesh. Of the sand returning to the mill, 46 per cent is —72 mesh. The pulp treated by the filter contains 65 per cent solids, and the cake formed carries 10 to 12 per cent moisture.

The recovery of the Butchart tables is 70 per cent of the lead and 65 per cent of the zinc contained in their feed. This low zinc recovery may attract attention, but it should be noted that even when ground to 2 mm. there is still a large quantity of middling (zinc and dolomite in physical combination); also, that in our ore the blende is unusually light and the dolomite markedly heavy. In treating the ores of the Orena mines, the property of this company, recoveries of 80 per cent of the zinc are obtained. However, I believe these tables impossible to improve upon, by reason of their special system of riffling and their mechanical construction. Their concentrate contains from 42 to 51 per cent zinc, according to the amount of pyrite which the ore contains; from 2 to 4 per cent lead, and 9 per cent dolomite.

The flotation concentrate contains from 51 to 54 per cent zinc, 2 to 3 per cent lead, and 7 per cent dolomite. The tailing contains from 1 to 4 per cent zinc, according to the proportion of oxide, carbonate, and silicate of zinc contained in the mine ore.

A New Ore-Sizing Screen

In describing the crushing plant, mention was made of a Barcena vibrating screen, of which a few details may be of interest.

In breaking down the ore to sizes suitable for concentration or to serve as feed to fine-grinding apparatus, there is placed at the discharge of each crusher, set of rolls, and complementary apparatus, a screening device to separate the sufficiently ground material from the oversize, which is returned for regrinding. The only satisfactory screening device known to me is the trommel, which is expensive to build and maintain when treating coarse ore, so attempts have been made to substitute shaking screens, obviously more economical apparatus. Nevertheless, no satisfactory device has been produced, for the rock or ore always breaks in angular pieces, which blind the screen and prevent its operation.

I personally received from the Dallmagne Co., of Irun, a shaking screen of perforated sheet with 1½ in. openings, which, according to the manufacturer, had a capacity of 7.5 tons per hour. This figure proved merely nominal, for in a half hour of operation all the openings had been plugged with ore. This screen was built similar to all others, with a frame suspended from the shaft and shaken by an eccentric. To this frame the perforated plate was fastened solidly by means of bolts. We modified this screen as follows: Instead of fastening the screen solidly to the frame, it is supported on flat springs, which, when the apparatus is in operation, produces vibrations of the screen cloth or plate, which in turn are imparted to the ore or rock, absolutely preventing the blinding of the openings and causing the material to move rapidly forward. To enhance this effect the plate may be given a longitudinal play of about 0.2 in. on the frame. As received from the Dallmagne Co. this screen was 47 in. wide and 11 ft. 9 in. long. Its normal capacity was 7.5 tons per hour, as stated, at 250 strokes per minute. Today this screen, because of the springs, has an effective capacity of 165 tons per hour. The specific gravity of this ore is 3.2. The position of these springs is of much importance in successful work. They are so arranged that a broken spring can be replaced in two minutes. A spring of suitable temper lasts 200 working hours. The wear on the perforated plate is insignificant.

Before closing I wish to say a few words regarding the machinery which has been purchased and its relative quality. That imported from the United States is of somewhat rough construction, but made with much practical sense—"fool proof." The Deister and especially the Butchart tables seem impossible of improvement. The machinery bought in England is of more careful construction, but I do not for this reason consider it superior to that previously mentioned. I am compelled to express myself in a different manner in speaking of that purchased in Spain, although it should be stated that only two factories are represented in our plant: Dallmagne, of Irun, and the Reocin shops of this company. Of the first I wish to say no more than that all the machinery furnished by it has been eliminated in six months. It was machinery made for sale but not for work. In our own Reocin shops were built our flotation machine, elevators, sand pumps, and minor parts, all of which work perfectly.

Thanks are expressed to D. Jose Maria Cabanas, director of these mines, for permission to publish these notes.

Only Sintered Ore Now Smelted in Mount Lyell Blast Furnaces

The Mount Lyell Mining & Railway Co., of Tasmania, reports that the fiscal year ended Sept. 1, 1922, was characterized by the development to its fullest extent of the modification of metallurgical treatment, involving the application of wet concentration methods to the whole of the North Lyell ore, and restricting blast-furnace operations to the smelting of concentrates after agglomeration by sintering. This has eliminated the use of Mount Lyell pyrites in the smelting process, except for a small amount required chiefly for the purpose of controlling the grade of matte, thereby producing a still further important decrease in the quantity of material dealt with in the blast furnace.

The changes made enabled the output of copper to be maintained with a material reduction in the number of employees, with a consequent reduction in the cost of production. Further additions are being made to the reduction works, and by the end of February, 1923, the plant was expected to be capable of treating 12,000 tons of ore from the North Mount Lyell mine.

Mining History of Mexico—II*

Government Stabilized Under Diaz—Industry Prospers—Liberalization of Code Benefits Large Foreign Companies, but Antagonizes Native Operator Against Outside Capital—The Collapse and the Present Situation

By H. A. C. Jenison
Geologist in Charge, Copper and Manganese, U. S. Geological Survey

PORFIRIO DIAZ, a most remarkable man, deserves more than passing mention, because under him Mexico received her first real hope, and made her only progress. Tolstoi wrote of Diaz:[1]

"Nature is an enemy to abrupt change; people who have remained long in a state of darkness and suddenly see the light, fall back dazzled. Precisely in this point consists the genius of the Mexican statesman; in the gradual and methodic counting of the pulse of the national existence. Another reformer of lesser talent would have made his country a multitude of demagogues without the law, without God, or a group of tyrants and slaves. But God knew how to avoid extremes, creating a government unique in the annals of history, which is in form a republic.

"Democracy, if I am not mistaken, is the idea of Diaz, and if to achieve this he may use autocratic methods, it is not his fault, but of the heterogeneous elements that constitute a national organism."

Tolstoi's eulogy is of interest as it indicates the dramatic effect of the contrast between Diaz and his predecessors rather than presents an accurate valuation of his character.

The first effort of Diaz was the restoration of peace and order in the country, and he was so effective that, in co-operation with the U. S. Army, northern Mexico was soon freed forever from the Comanche and Apache depredations, and with the exception of the Yaqui country the entire area of Mexico was freed from bandits. This condition of safety was novel to the country, but when men finally realized that it was true, prospectors and engineers penetrated the most remote mountains, isolated mining camps were established, and bullion was transported long distances with small native guards without appreciable risk. Diaz successfully encouraged the construction of railways and the extension and improvement of other transportation facilities; he furthered the reduction of mining taxes, encouraged the national Congress to amend the mining code in 1884 and in 1887 to the advantage of foreign capital. The code of 1884, which was promulgated and compiled by mining engineers and lawyers, unified the laws of the country and ended the right of the individual states to legislate on mining matters.

All these sweeping reforms were essential not only to the mining industry but to the economic life of the country, as both the country and the government depended almost entirely upon the industry for their prosperity and their revenue. The low price of silver during that period threatened the life of the industry, despite the efforts of Diaz and his government, and to meet the situation the state taxation was fixed at a minimum of 2 per cent, materials necessary to mining were relieved of taxation and import duties; coal, iron and mercury mines were exempt from state taxation for fifty years; rates of taxation on beneficiation and reduction plants were limited to the general rate.

The President was empowered through the code of 1887 to make special contracts with companies which would invest not less than $200,000 within five years upon mining or metallurgical enterprises. These special contracts usually consisted of special franchises or concessions relieving them of all taxes for a period of ten years.

Prior to about 1880 no coal had been mined; lead had been mined principally in connection with silver, and copper had been mined almost entirely for the manufacture of *magistral* necessary in the *patio* process, but from 1880 on, lead, coal, and copper were produced in comparatively large quantities.

The construction of railways and development of other means of transportation made the more remote regions accessible, made the transportation of heavy machinery possible, and the shipment of low-grade ores to smelters profitable. Thus Mexico entered upon a new era in her political history and a new and sweet experience in her industrial life.

In the early 80's the small foreign mining companies which had ventured their small capital in Mexico during the previous few years began meeting with some success, and thus drew the support of strong financial interests, or their success encouraged strong companies to risk their large capital in what developed into a revolution of Mexican mining. The mining codes of 1884 and 1887 greatly encouraged the large companies, among the first of which were the American Mining Co., now non-existent; the Batopilas Mining Co., and the Compagnie du Boleo. These companies had plenty of capital, which was successfully used in development of large profitable mines. The success of these companies so encouraged others that in a few years the entire country was the scene of exciting, optimistic, and often profitable prospecting and development.

The investment of foreign capital in Mexico proceeded at an astonishing rate, and in a few years' time the total invested capital from foreign sources was many times its amount when Diaz came into control.

For the first time, the metallurgical industry, as a distinct and large-scale industry, became important and necessary to the welfare of the mining industry, and particularly to the small operators. Prior to about 1890 most of the ores which required smelting had been shipped into the United States. These long rail shipments involved such great freight charges that the low-grade ores which have since been so productive could not be profitably treated. The Mexican Government, realizing the situation, offered special inducement to metallurgical companies in the form of grants consisting principally of tax exemptions, supplemented by the favorable legislation of several states.

About this time the Windom law, which was intended to protect the lead producers of the United States from competition with the lead ore from the Sierra Mojada (Coahuila) mines, was enacted by the United

*The concluding article of a series of two on the subject.
[1]Jorge Griggs, "Mines of Chihuahua," p. 5.

States Government, and such high duties were levied on imported lead ores that they could no longer be profitably exported from Mexico to the United States. With this further inducement, numerous companies soon undertook the construction of smelters, and among the first and most successful were the Guggenheims, who, under a concession in 1887, were allowed the free importation of machinery, construction materials and coke from the United States. Between 1890 and 1895 they built smelting plants at Monterey and Aguascalientes, and later at Velardeña, Chihuahua, and Matehuala. The same interests also acquired about ten important mining properties and an important railway system. These plants, mines, and railways are at the present time controlled by the American Smelting & Refining Co. or its subsidiaries.

Among the other important builders of smelters were the Cia. Metalurgica Mexicana, which constructed a large plant at San Luis Potosi in 1892 and treated ores from numerous states. At Mapimi, in Durango, the Peñoles company, which was at that time a German-Mexican concern, erected a small plant. The most important of the Mexican-owned plants was the one erected at Torreon by the Cia. Metalurgica de Torreon. In addition to the plants built by the regular smelting companies, some of the more important copper companies erected smelting plants to handle both their own and a considerable tonnage of custom ore.

Contemporaneously with the increasing investment of foreign capital and the institution of smelting operations, the price of silver continued to fall and presented a serious difficulty to the expansion of the silver-mining industry during the early 90's, and was probably responsible in part for the impetus given copper mining. This condition induced the revision of the mining law in 1892, which prescribed the payment of taxes as the sole requirement for the retention of ownership of claims—a radical departure from the code of 1884, which provided that at least six men must be employed on a claim for not less than twenty-six weeks out of the year.

The taxes were based upon the number of pertenencias in a claim, which was at this time increased to 100 meters square or an area of one hectare (2.47 acres). The taxes imposed by this new code required the payment of a sum of $10 in gold annually in three installments for each pertenencia in a claim, and an additional stamp tax of the same amount payable upon the issuing of the patent to the claim. By 1905 these rates were modified by the reduction of the stamp tax to 5 pesos per pertenencia and the annual tax to 6 pesos per pertenecia for claims of twenty-five or fewer pertenencias and 3 pesos per pertenencia in excess of that number. Under these legal provisions strong financial interests were enabled to denounce and hold, for their strategic or potential mineral value, great areas for slightly more than $1 an acre in stamps and a maximum annual tax of about the same amount. Thus what had been intended as an encouragement to the investment of large capital was so successful as such that the intrusion and competition of rival companies or individuals in a district could be prevented.

Its principal advantage to the nation as a whole consisted of the creation of conditions favorable to a mining company's acquiring and proving a sufficient supply of low-grade ore to justify extensive development work and great outlays of capital for machinery and reduction works. These provisions were, however, extremely disadvantageous to the small miner and the company with small capital, particularly native companies, and furthered the concentration of the mining industry of the country into the hands of a few foreign companies, thus retarding its development; they largely excluded the native Mexican from an extensive share in the natural resources of his own country and resulted in the creation of much bitterness toward the foreigner.

In 1894 additional legislation was passed to stimulate production of gold. This new law was, in effect, a recapitulation of the policy and privilege of the Executive to make special contracts with companies or individuals, but limited such contracts to one year and covered only gold placers. It resulted within six years in increasing the gold production to about 445,000 oz.

It is not surprising, therefore, that under such favorable legislation and such thorough control of conditions in general in Mexico by Diaz the investment of foreign capital, at this time mostly American, proceeded at an enormous rate. This great investment of American capital was the goal sought by Diaz during the previous twenty years, and it undoubtedly contributed greatly to the progress and wealth of Mexico, but it was not without serious drawbacks, which contributed in a large measure to the last ten or twelve years of chaos. This was due largely to the fact that with the increase in investment of foreign capital the investment of Mexican capital decreased. In a word, all foreign capital, American capital in particular, excluded Mexican capital from mining operations. By the end of 1912, Cleland[2] estimates, the total investment in mining enterprises throughout Mexico was about $323,600,000, of which less than $15,000,000 was Mexican. The following table from the same author indicates the investment of foreign capital by nationalities:

	American	British	French	Mexican (*a*)	Miscellaneous
Mines	$223,000,000	$43,000,000	$5,000,000	$7,500,000	$7,830,000
Smelters	26,500,000	.....	... .	7,200,000	3,000,000

(*a*) The acquisition of the chief Madero properties by the American Metal Co. greatly reduced the above valuation of Mexican holdings.

Other reliable estimates are notably higher, and indicate a considerable amount of Spanish and German capital, a large part of the latter evidently being considered by Cleland as American, but the salient features are identical in all estimates. Two facts may be gleaned from this table, which affords a striking indication of the period of prosperity which ended in 1910: (1) the tremendous growth of the Mexican mining industry in a few years; and (2) the extraordinarily small part that the Mexican played in this development except to furnish the resources and the labor and see the profits go abroad.

The overthrow of Diaz was not immediately felt, and the world at large and the mining industry in particular showed a general confidence in the security and stability of the new government as well as in the fundamental soundness of the country as a whole. During 1910, 1911, and 1912 Mexico made her greatest production of metals, and there was little destruction of property or interference with communication. The disturbances were almost purely political, and directed solely against the government. Toward the end of 1912, however, it became apparent that the country was swiftly reverting to a period of political, social, and commercial chaos and collapse. By the end of 1913 all

[2]Mexican Year Book, p. 279.

faith in the existing government was lost, and the mining companies were facing a crisis.

Excellent discussions of the conditions may be found in the "Mexican Year Book," by R. G. Cleland: "The People of Mexico," by Wallace Thompson; "Mexico, Its Reconstruction," by Chester Lloyd Jones; and "Mexico on the Verge," by J. M. Dillon.

The problems which confronted the mining industry were of different but closely related character, the most widely known of which was the general lawlessness which prevailed throughout the country, and the other, the federal government activities. The outlying districts were characterized by the insecurity of life and property, a condition thoroughly comparable to the period preceding Diaz. Raids, "confiscation" of supplies, ore, concentrates, and bullion, levying of tribute, and the kidnaping and murder of employees by bandits and guerillas became commonplace. Destruction of railway lines and rolling stock and the parasitical existence of large bodies of unproductive men further complicated the situation.

Most mines and smelters were soon reduced to expensive, insecure, intermittent operation and many were forced temporarily or even permanently to abandon their properties. Cleland[3] states that the co-operation of the government with the larger companies in the effort to maintain rail transportation consisted of furnishing fuel and paying the train crews, while the companies furnished and maintained the rolling stock and paid the government the regular freight rates.

The federal government's activities which created difficulties for the mining industry consisted principally in increased taxes and in the new Constitution of 1917. Mining being one of the chief sources of public revenue in times of financial stringency, the Mexican Government repeated its earlier similar attempts to increase its revenue from this source. On March 1, 1915, under the Carranza regime, the stamp tax was increased to 10 pesos per hectare, and a progressive pertenencia tax, which varied from 12 pesos per pertenencia for property containing one to ten pertenencias to 24 pesos per pertenencia for property containing 51 or more pertenencias, was levied. In conformance with the apparent communistic principles of the government, this tax was evidently intended to offset the advantages given large industries under the Diaz regime by preventing further speculation in undeveloped properties and breaking up some of the large holdings of foreign companies as well as increasing the revenue. In 1916, by presidential decree, the law of March, 1915, was modified and changed in important particulars, among which was the imposition of a 10 per cent ad valorem duty on gold and silver exports and 5 per cent on other metals. This new law also contained provision by which taxes unpaid by March 1 of the year were subject to a maximum penalty of 200 per cent and permitted the several states to collect a production tax of 2 per cent, and the surcharge on state taxes payable to the government was increased from 25 to 60 per cent[4].

Under the decree of Sept. 14, 1914, the operation of all mines in Mexico was required, and failure to comply with this requirement subjected the property to operation by the government or the annulment of title. This provision was directed to correct so-called evils of the law of 1892 and to compel the working of idle property for the benefit of the laboring classes and the public revenue, and to prevent speculation.

In the Constitution of 1917, the most dangerous provision of the previous law consists of the famous Article 27, which declares the original national ownership of all lands and waters and of the national right to the creation of private property. The constitutional requirements at the present time, under Article 27, are as follows:

"I. Only Mexicans by birth or naturalization and Mexican companies have the right to acquire ownership in lands, waters and other appurtenances or to obtain concessions to develop mines, waters, or mineral fuels in the Republic of Mexico. The nation may grant the same right to foreigners provided they agree before the Department of Foreign Affairs to be considered Mexicans in respect to such property and accordingly not to invoke the protection of their governments in respect to the same, under the penalty, in case of breach, of forfeiture to the nation of property so acquired. Within a zone of 100 kilometers from the frontiers and of 50 kilometers from the seacoast, no foreigners shall under any condition acquire direct ownership of lands and waters. . . .

"VII. All contracts and concessions made by former governments from and after the year 1876 which shall have resulted in the monopoly of lands, waters, and natural resources of the nation are declared subject to revision, and the Executive is authorized to declare those null and void which seriously prejudice the public interests."

Under such conditions it may readily be seen that the greater part of the industrial development of Mexico and the exploitation of natural resources, concessions for which have been granted, is subject to the whims and political vicissitudes of the Executive rather than upon equity or court decisions. These communistic legal restrictions are the direct result of the abuses of the earlier foreigners' property rights and make the subject of property ownership in Mexico one of a serious nature, in which the future rights of a foreign company to its concession are so indefinite as to discourage the investment of foreign capital. Recent Supreme Court decisions are on record as opposed to the retroactivity of the article, but as yet, in view of the limited or questionable authority of the Supreme Court, the interested public does not believe that it has had adequate assurance of the integrity and the inviolability of property and concessions. The issue has been raised principally on the basis of the oil lands, but it applies with equal comprehensiveness to all natural resources[5].

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[3] *Ob. Cit.*, p. 277.

[4] A good discussion of the modification of these taxes may be found in the "Mexican Year Book," by R. G. Cleland.

[5] For a discussion of the politics and government and the present constitution the reader is referred to Section 2, (Politics and Government) of the "Mexican Year Book," by Herbert Ingram Priestley, of the University of California.

Smelting Silica Bricks With Reverberatory Slags in a Copper Blast Furnace

Special Conditions in the Treatment of Native Copper Ores During the World War Made Unusual Charges Necessary —No Difficulties When Materials Were Properly Combined

By Robert F. Wood
Superintendent Bayonne Works, International Nickel Co.

Robert F. Wood

TWO MATERIALS, each of which alone would be an undesirable addition to the charge to a copper blast furnace, may be so combined as to eliminate most of the troublesome factors incident to their use. For instance, charges of such opposite and unusual character as copper-impregnated silica brick and reverberatory slag, low in silica and rich in copper, were used together in the work to be described, the results being extremely satisfactory considering the unsuitability of materials of this kind for blast-furnace smelting. Before describing the treatment in detail, it will be desirable, for comparison, to examine into normal conditions of operation.

In a plant smelting native-copper ores, the chief function of the copper blast furnace, or cupola, is that of scavenger of the plant. Of the materials that it treats, slag *F* (Fig. 1) from the reverberatories is the chief item. From this reverberatory slag the blast furnace removes the copper, *I*, leaving a comparatively clean waste slag, *H*.

Fine concentrates may also be smelted in the blast furnace, provided they are first briquetted. This has been done at times in preference to reverberatory treatment, because, on account of the low copper contents of this grade of material, the reverberatory slag resulting from it is likely to carry away a rather large proportion of the copper charged. As between briquetting such material and thus preparing it for blast-furnace treatment, or slagging it in the reverberatories, the choice rests largely upon the economics of smelter operation. The cupola has been used also to smelt small pieces of mass copper instead of putting them through the reverberatories. When this is done the pieces of mass are introduced from time to time with the reverberatory slag. This application, however, is hardly more than incidental. In general, then, it may be said that reverberatory slag is almost the only material that comes in for blast smelting.

In running the blast furnace, the metallurgical problem is so to flux and smelt the slag as to get, simultaneously, smooth furnace operation and an effective separation of the copper from the waste slag. If either of these two conditions is thrown out of its proper relation, the results will not be of the best. Possible sources of trouble, aside from accident, fall into two distinct classes:

(a) High losses of copper in waste slag. This may take place even though the furnace is running smoothly, for the waste slag may be of such composition or consistency that the globules of metallic copper will not settle out as they should; or the atmosphere in the smelting zone may not be sufficiently reducing, thus allowing some copper to enter the waste slag as oxide.

(b) Obstructions or "salamanders" may form in the furnace, or local freezing may take place. A reducing atmosphere, though favorable to low losses of copper, may promote this difficulty, especially with a slag of such composition as will allow easy reduction of iron. The reduced iron, with the copper already present, goes to make up the "salamander." This condition is often hard to detect at the start, as the furnace may apparently be operating efficiently and satisfactorily and yet be developing internal conditions which may force a shutdown eventually.

Even though all the above-noted sources of difficulty are avoided by correct proportioning of fluxes, blast, and fuel, it is essential carefully to observe the rate at which the metal drops into the crucible, or, in other words, the amount of copper contained in the charge, which itself has an important bearing upon the behavior of the furnace. If the charge contains too little copper, the heat carried down toward the bottom will be insufficient to keep the furnace clear and the tapping spouts open. This would be a characteristic of the copper-soaked bricks, if smelted by themselves. On the other hand, if the precipitation of copper is too heavy, too frequent tapping becomes necessary, so that the tap holes are likely to burn out or become uncontrollable, and the slag losses will probably be high. This would be a characteristic of the special type of slag to be described later, if smelted by itself. Charge material requiring excessive quantities of flux is also undesirable, and this, again, was a prominent characteristic of the bricks, because of their high silica content.

The foregoing observations apply in particular to the type of furnace, class of material, and mode of operation herein to be described. This blast furnace, or cupola, was a water-jacketed furnace about 6 ft. long by 3 ft. wide, with bricked-up crucible. Tuyères passed through both sides and both ends of the furnace; spouts were provided at both ends and on one side for tapping copper, the opposite side being given over to slag spouts and settlers. The charging door was approximately 10 ft. above the tuyère level; charges, consisting usually of 2,000 lb. of reverberatory slag with appropriate fluxes and fuel, were introduced at intervals of from twenty to thirty minutes. Waste slag escaped continuously through the trapped spout at the side, whence it issued at a rate of flow corresponding to the rate of fusion within the furnace. The copper spouts were opened intermittently, and in rotation, the intervals depending upon the rate at which the copper accumulated in the hearth.

A typical charge consisted of 2,000 lb. of regular run of reverberatory slag, with 500 to 700 lb. of limestone and 150 to 250 lb. of iron ore or pyrite cinder as fluxes. Typical compositions of these materials and also of the resulting waste slag were:

Material	Cu, Per Cent	SiO_2 Per Cent	FeO, Per Cent	CaO, Per Cent	Al_2O_3, Per Cent	Remainder
Reverberatory slag	15	40	16	13	10	6
Limestone	...	2	...	53	1	1+ CO_2
Pyrite cinders	Trace	5	80	...	2	2+ oxygen
Waste slag	...	36	22	27	8	6+

The expected composition of the waste slag may be found as follows, applying the above percentages to the weights taken of each material:

		Contents (Pounds)					
Material	Weight Charged, Lb.	SiO_2	FeO	CaO	Al_2O_3	Other Ingredients Entering Waste Slag	Total Entering Waste Slag
Reverberatory slag	2,000	800	320	260	200	120	1,700
Limestone	600	12	...	318	6	6	342
Pyrite cinders	250	12	200	...	5	5	222
Totals	2,850	824	520	578	211	131	2,264
Expected composition of waste slag, (per cent of 2,264)		36.4	23.0	25.6	9.2	5.8	100

This waste-slag composition may be taken as typical for usual conditions. With 15 per cent copper in the reverberatory slag, a charge such as the one given above would yield close to 300 lb. of copper; the yield of waste slag is seen to be 2,264 lb. With a charging interval of about twenty-five minutes, or say two and one-half charges per hour, the copper yield would be 750 lb. per hour, which would be considered normal operation, allowing as it does a withdrawal of around 400 lb. every half hour.

The copper-soaked silica bricks, resulting from repairs made periodically on the reverberatory furnaces, were so high in silica and so difficult to flux and smelt that the recovery of copper from them presented a somewhat difficult problem. Occasionally some of them were disposed of by careful admixture with a high-iron reverberatory slag in the blast furnace, and this worked fairly well, but did not dispose of them in sufficient quantity. Admixture with regular run of reverberatory also failed to give satisfactory results. A considerable stock of such bricks therefore accumulated, waiting for some other method of treatment. To run such material by itself was out of the question. However, a hypothetical charge for it is given in Table I, which will visualize the difficulty and will also serve as a basis upon which to make out the "combination charges" that were finally used.

It will be observed in Fig. 1 that the chief charge material of the reverberatories consisted of concentrates, *A*, and that accordingly their chief product was the resulting copper, *D*, of high conductivity and purity. It will be seen also that whatever copper went into the reverberatory slag, *F* (and hence had to pass through the cupola, *G*, for recovery), came back to the reverberatories again in the form of blocks, *I*, which were impure and which in turn had to be melted and refined. The impurities in these blocks were chiefly iron, sulphur, and arsenic, picked up from the fluxes; fuel, and gangue, with which the copper was associated during smelting. Typically, this copper, *I*, might contain 4 per cent iron and 0.7 per cent sulphur, with enough arsenic present to bring down the electrical conductivity of the refined product, *E*, after removal of iron and sulphur in the reverberatories, to around 90 per

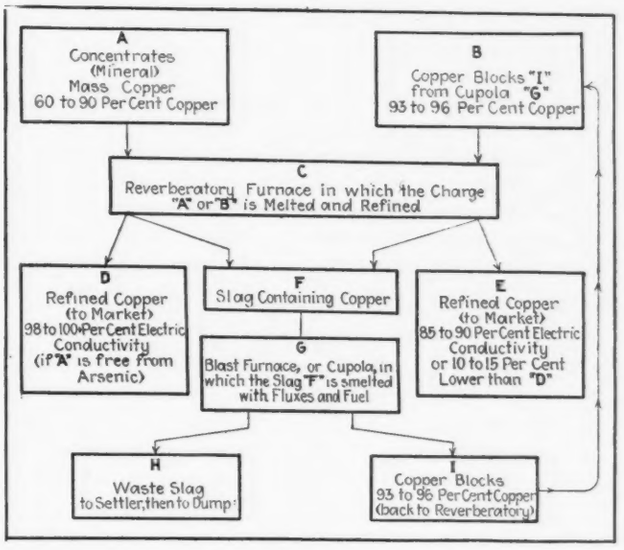
A
Concentrates (Mineral) Mass Copper 60 to 90 Per Cent Copper
B
Copper Blocks "I" from Cupola "G" 93 to 96 Per Cent Copper
C
Reverberatory Furnace in which the Charge "A" or "B" is Melted and Refined
D
Refined Copper (to Market) 98 to 100 Per Cent Electric Conductivity (if "A" is free from Arsenic)
F
Slag Containing Copper
E
Refined Copper (to Market) 85 to 90 Per Cent Electric Conductivity or 10 to 15 Per Cent Lower than "D"
G
Blast Furnace, or Cupola, in which the Slag "F" is smelted with Fluxes and Fuel
H
Waste Slag to Settler, then to Dump
I
Copper Blocks 93 to 96 Per Cent Copper (back to Reverberatory)

Fig. 1. Smelter flow sheet

Adapted from "Diagram of Operations," page 144, "The Copper Mines of Lake Superior," by T. A. Rickard.

cent, compared with 100 per cent conductivity on first-melt metal.

Copper of the higher conductivity usually entered the domestic market, whereas much of the arsenical metal was exported. When, in 1914, the European market was shut off, it became necessary either to find a new market for the arsenical grades, *E*, or to eliminate them by using a special refining process which would get rid of the arsenic and thus increase the purity and the

TABLE I

Material	Weight Lb.	SiO_2 Per Cent	SiO_2 Weight, Lb.	FeO Per Cent	FeO Weight, Lb.	CaO Per Cent	CaO Weight, Lb.	Al_2O_3 Per Cent	Al_2O_3 Weight, Lb.	Other Ingredients Entering Waste Slag Per Cent	Other Ingredients Entering Waste Slag Weight, Lb.	Total Entering Waste Slag Per Cent	Total Entering Waste Slag Weight, Lb.
Copper bricks	800	75	600	2.5	20	1.5	12	1.5	12	2.5	20	83	664
Limestone	1,030	2	21	...	...	53.0	546	1.0	10	1.0	10	57	587
Pyritic cinder	800	5	40	80.0	640	....	...	2.0	16	2.0	16	89	712
Totals	2,360		661		660		558		38		46		1,963
Expected composition of waste slag (per cent of 1,963)			33.7		33.7		28.4		1.9		2.3		100

With 15 per cent copper present in the bricks, there would be a yield of only 120 lb. of copper per charge, which would be insufficient to keep the lower part of the furnace hot and clear. This, and the excessive fluxing required by the mixture, would make the charge impracticable to run.

The slag referred to above was a reverberatory-furnace product, resulting from a special refining process applied to copper recovered by the cupola.

electrical conductivity of the resulting copper so as to obtain a grade of metal comparable in quality with first-melt metal, *D*. The latter course was followed so far as possible, this being done by using the "soda-lime" process of refining, when treating the blocks, *I*, in the reverberatories.

I shall here go no farther into the details of this process, which has been used at different places and times, than to outline what is of particular interest in

the present connection. The treatment with soda and lime, when continued for a period sufficiently long to expel the arsenic from the metal and thus obtain a pure product of high conductivity, entailed the production of a considerable quantity of slag in addition to the normal or customary amount. This additional slag carried so high a percentage of cuprous oxide that it was entirely unfitted for unmixed smelting in the blast furnace. A hypothetical charge, however, is given in Table II for consideration.

The copper in this slag was 58 per cent, giving 1,160 lb. of copper on the above charge, which would be more than enough to cause the difficulties previously noted, resulting from too rich a charge material, with too rapid accumulation of copper in the hearth of the furnace.

Comparison With Usual Materials

Comparing, now, the three classes of material under consideration, there is first the normal, workable charge for the regular run of reverberatory slag, and then the two hypothetical unworkable charges of opposite characteristics for the two special materials. Analyzing these characteristics, they may be tabulated in Table III.

This shows the contrast between (2) and (3), and indicates that they might be combined in such proportions as to approximate more or less to the typical conditions shown for the regular reverberatory slag, (1). This is what was done, in effect, and will now be described.

Actual Conditions During the Trial

On account of the experimental nature of charges containing special slag or bricks, their first trial was timed just before the cupola was to be shut down, at the last end of a run, so as not to interfere with regular operations if difficulties should arise with the new mixtures. It so happened that toward the end of this run the furnace was not in the best condition, partly on account of a water-jacket leak on the inside of the furnace. Furthermore, two of the three copper-tapping spouts had become closed, so the new charges were to receive none too fair a chance. Despite this handicap they were found to work well. Several different proportions of the regular and special reverberatory slags were used without any bricks, and these were followed, at the very end of the run, by brick admixtures, all successfully.

Proportioning the Combination Charges

In proportioning the trial charges it was considered inadvisable to attempt any mixture that would yield copper faster than about 1,800 lb. per hour, this being nearly three times the normal rate. Allowing three taps per hour, the weight of each tap would be 600 lb. which it was thought would be the maximum amount permissible for frequent tapping. Allowing two and one-half charges per hour, the permissible weight of copper per charge would accordingly be 720 lb. This was afterward found to be a little too high.

In the table which follows several representative combinations are given:

Mixture No.	Materials of Charge: Reverberatory Slag	Special Slag	Copper Bricks	Fluxes: Limestone	Pyritic Cinder
1	1,000	1,000	...	385	165
2	1,300	700	...	425	165
3	1,500	500	...	500	190
4	1,300	700	...	475	200
5	500	750	250	565	370
Reverberatory	2,000	....	...	600	250

Mixture No.	Approximate Weight per Charge, in Lb.: Copper Contents	Waste Slag Made	Copper and Waste	Ratio Copper Contents to Weight of Waste Slag	Weight of Copper per Hour
1	730	1,555	2,285	0.47	1,825
2	600	1,730	2,330	0.35	1,500
3	515	1,900	2,415	0.27	1,288
4	600	1,790	2,390	0.33	1,500
5	550	1,540	2,090	0.36	1,375
Reverberatory	300	2,264	2,564	0.13	750

It will be observed that in each operation the combined charge was diluted with regular reverberatory slag, which was done as an expedient to minimize the effect of any variations that might occur in the untried constituents of the charge.

Smelting the Charges

Mixture No. 1 started out well, but made too much copper, which was the reason for going over to No. 2. Furnace trouble developed on No. 2, but this was attributed to the condition of the furnace, already mentioned, rather than to anything inherent in the mixtures. The correctness of this conjecture was borne out later, when, after running the lighter mixture No. 3 for awhile, merely as a matter of precaution, a return was made to mixture No. 2, and no trouble developed. However, as there was a slight change in the fluxes on returning to this charge, it is re-listed in the table as No. 4. At times during the trial of these new mixtures, a few charges of regular reverberatory slag were run, which was done both as a precaution and as a corrective measure if the furnace showed any signs of irregularity. This practice, however, was soon discontinued. Upon introduction of the fifth mixture, the one containing the copper bricks, the furnace ran more smoothly, if anything, than before. Variations of this charge, containing from 100 to 300 lb. of copper bricks, were run at different times later on, in accordance with prevailing conditions, and by their use it was eventually found possible to put through as high as forty tons of copper bricks, equivalent to over 10,000 lb. of copper, per week. together with the other charge materials as shown in the table.

In regard to methods for computation of the above charges, it may be said that the proportions of flux

TABLE II

Material	Weight, Lb.	SiO_2: Per Cent	SiO_2: Weight, Lb.	FeO: Per Cent	FeO: Weight, Lb.	CaO: Per Cent	CaO: Weight, Lb.	Al_2O_3: Per Cent	Al_2O_3: Weight, Lb.	Other Ingredients Entering Waste Slag: Per Cent	Other Ingredients Entering Waste Slag: Weight, Lb.	Total Entering Waste Slag: Per Cent	Total Entering Waste Slag: Weight, Lb.
Special slag	2,000	16	320	6	120	6	120	1	20	5	100	34	680
Limestone	250	2	5	...	...	53	132	1	3	1	3	57	143
Pyritic cinder	160	5	8	80	128	...	...	2	3	2	3	89	142
Total	2,410		333		248		252		26		106		965
Expected composition of waste slag (per cent of 965)			34.5		25.7		26.1		2.7		11.0		100

TABLE III

Kind of material	Copper Yield: Lb. per Charge	Copper Yield: Lb. per Hour	Waste-slag Yield: Lb. per Charge	Waste-slag Yield: Lb. per Hour	Ratio of Copper Yield to Waste-slag Yield	Ratio of Flux to Material	Ratio of Flux to Gangue
(1) Reverberatory slag	300	750	2,264	5,660	0.13	0.42	0.50
(2) Copper bricks	120	300	1,963	4,907	0.06	2.30	2.69
(3) Special slag	1,160	2,900	965	2,412	1.20	0.21	0.49

were usually determined by trial and error, endeavoring to hold to the type of waste slag previously mentioned, with as economical a use of fluxes as possible. With the more complex charges it was sometimes easier to use algebraic methods, by setting down the conditions in the form of simultaneous equations, but it is not necessary here to describe the procedure for doing this. Whichever method was used, due attention had to be paid to the principles laid down in the early part of this paper, to insure a practical charge.

Comparison of Expected and Actual Compositions of Waste Slag

Close correspondence was usually secured between computed or expected compositions of waste slag and its actual analysis. With the five mixtures given above, the comparison was as follows:

	Per Cent			
	SiO_2	FeO	CaO	Al_2O_3
Expected	35 to 38	22 to 27	25 to 27	7 to 9
Obtained	35 to 37	20 to 24	24 to 29	8 to 13

Charging-Floor Practice

Before concluding, it may be mentioned that in the treatment of materials such as I have been considering, practice on the charging floor was also of importance. Everything was weighed, and care was taken to dump the different ingredients of the charge into the furnace so they would become mixed together and thus smelt more easily. At the same time, this plan was not followed blindly, as certain exceptions were made. For instance, the special slag, with its high copper content, was not allowed to drop in close proximity to the slag spout. Another modification of the general rule was in the case of any easy-smelting material, which was often charged so as to fall near the ends of the furnace. This helped to keep the furnace open by giving the easier work to those parts that were most likely to become cold.

Conclusion

All these precautions were followed and were found to be helpful, but in spite of them there developed at times a tendency toward formation of "salamanders" when smelting these mixtures; this may have been due to some undetermined relation between slag composition and the reducing conditions within the furnace. However, considering the unusual and comparatively difficult materials, the results were satisfactory, and a good recovery was secured.

Banka Smelters—Marketing Government Tin

In contradistinction to the practice on the island of Billiton, the tin of Banka, in the Dutch East Indies, is smelted on the island itself. Formerly each tin field had its own smelter, but during the last year the smelting has been considerably centralized, and at present there are two reduction plants only at Blinjoe. Besides the vertical kiln, which is still being used for smelting the ore (the so-called Van Vlaanderen furnace), the flame furnace has recently been put into operation in Banka, through which the loss of tin will be greatly reduced. The tin of Banka is considered to range among the purest found; a purity of 99.97 per cent is guaranteed, which is, however, usually exceeded. There has long been an agitation to concentrate all the tin-smelting activity at one place, especially that with reference to the Banka and Billiton outputs, according to *The Far Eastern Review.*

Before the war all of the government (Banka) tin was shipped by the Nederlandsche Handel Maatschappij and auctioned in Holland, no sales being effected in the colony, but since that time all sales are conducted direct by the government at Weltevreden, Java.

According to report, low prices and a lack of demand have resulted in large accumulations of tin stocks here and at Singapore, the total amount of which is difficult to estimate. A few months ago it was reported that the governments of the Federated Malay States and of Netherlands India had agreed to withhold stocks from the market until prices improved, or at least to limit the export to small quantities. It was also reported that the Banka and Billiton mines would be closed down pending an improvement in prices, but the latter report has not been confirmed.

Bath a l'Alaska

By Leroy A. Palmer

In *Engineering and Mining Journal* for Jan. 31, 1920, I described a substitute for a bath which can be performed in the desert. The accompanying illustration shows how the same thing may be done upon occasion in Alaska.

Interior view of outdoor Alaskan bath house

The bath house is made of logs laid vertically. In the roof is a hole which can be covered by a slide. Within is a rock fireplace and a five gallon gasoline can. A portion of the ablutionary vessel proper—get that, please—is shown leaning against the wall at the left.

When you want a bath you fill the gasoline can with water, built a fire in the fireplace, open the slide in the roof, and close the door. When water and rocks have had plenty of time to get hot you draw the fire, let the smoke clear out through the hole in the roof and close the slide. Then you throw part of the hot water over the rocks so as to make steam and heat your bathroom, pour the rest of it into the galvanized iron tub, cool it to bearable temperature, and proceed to bathe. A bunch of green alder twigs with the leaves on used as a bath brush completes the equipment.

By varying the amount of water thrown on the hot rocks the temperature of the room can be controlled, and, if desired one can get a real Turkish steam bath. Crude? Well maybe so; but try it once after a hard day's "mush" over the tundra; and you won't envy the man with the best "room and" between the Ritz and the Palace.

The Designation of Polymetallic Ore Deposits With Flag-Marks

A Graphical Method of Picturing Important Geological and Mineralogical Features of Mines on Topographical Maps

By A. K. Boldirev
Geologist, Russian Geological Committee

THE MOST IMPORTANT peculiarities of polymetallic ore deposits which should be shown on a map are the following: (1) Geographical location, (2) kind of useful mineral, (3) strike and dip, (4) estimated tonnage of ore in the deposit (entire output and ore in sight), (5) relation between the distribution of the ore deposits and geological structure of the region, (6) lithological character of ore-bearing rocks, (7) commercial or non-commercial character of ore deposit, (8) percentage of each metal in the ore, (9) value of different metals per unit of the ore.

A flag-mark and a cross flag-mark are convenient and simple characters for the designation of the peculiarities listed. The former can be used for commercially workable deposits and the latter for those deposits which are not commercial.

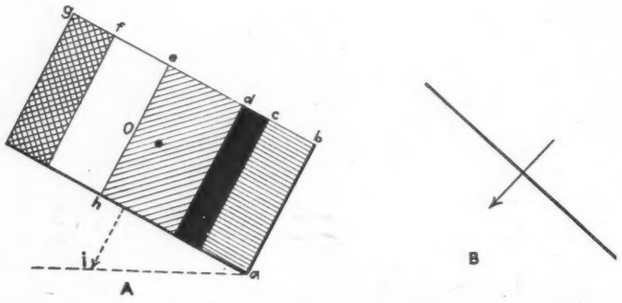

Fig. 1—Marks used in picturing features of ore deposits.

Fig. 1 (A) shows a flag-mark (enlarged) for a deposit containing five metals. All peculiarities mentioned are designated in the following manner:

1. The circle in the center of the rectangle designates the geographical location of the deposit.

2. The color or shading of the small rectangles specifies the kind of metals.

3. The arrow shows the dip, and the perpendicular side of the rectangle the strike. The angle *h i a* is the dip angle. The line *a i* is not to be drawn on the map.

4. The side *a b* is proportional to the tonnage of known ore reserves in the deposit.

5. The light geological coloring of the map shows the relation between the location of the deposit and the geological structure of the particular region.

6. The color of the arrow designates the lithological character of the ore-bearing rock.

7. As mentioned above, this flag-mark refers to commercially workable deposits only. The deposits which are not commercially workable are designated by cross-marks explained below.

8. Sections *bc, cd, de, ef,* and *fg* are in proportion to the metallic contents (in per cent) of the ore, but by the use of a different scale for each metal. Namely, 1 mm. of these intercepts is the equivalent for each metal in the so-called "scale-tenor," which is inversely proportional to the price of a unit of weight of the metal:

$$t_1 : t_2 : t_3 : \ldots\ldots = \frac{k}{p_1} : \frac{k}{p_2} : \frac{k}{p_3} : \ldots\ldots$$

where k is constant for all the metals and for the entire map (t means tenor and p price).

Thus, when an ore or different ores have scale-tenors of different metals, the value of each metal contained in one ton of ore remains the same.

Now, in Fig. 1 (A), sections *bc, cd, de, ef, fg* show the value of different metals contained in a metric ton of ore of the designated deposit. And the whole length of the side *bg* of the rectangle shows the total value of the metallic content in a ton of specified ore.

According to the scale of the map and the richness of the deposits we can choose the coefficient k, so that the flag-marks should be as large as possible; they must not be, however, too large, and they ought not overlap one another. For instance, for the map of the Russian Altai polymetallic ore deposits where the scale was 1 in. = 20 versts (13.3 miles), and the highest value of the ore is about 120 gold rubles ($60) per metric ton, we have used the following scale-tenors for the five metals.

Metal	Average London Price for 1904-1913 (Rubles per 1 Kg.)	Scale-Tenor Corresponding To 1 Mm. of the Flag-Mark in Per Cent
Au	1,291.79	0.00047
Ag	36.86	0.016
Pb	0.14	4.3
Zn	0.22	2.7
Cu	0.63	0.95

Note. Average price multiplied by "scale-tenor" equals roughly 0.6 rubles for each metal. It is the value of the metal contained in 1 kg. of designated ore. According to these scale-tenors, the maximum size of the flag-marks along the strike reached 20 mm. on the map, to wit:

$$\frac{120 \text{ rubles}}{1{,}000 \text{ kg.} \times 0.6 \text{ rubles}} = 20 \text{ mm.}$$

9. It is evident that the area of each separate rectangle is proportional to the value of the corresponding metal contained in each respective deposit.

The cross-mark (Fig. 1 (B)) is a schematic flag-mark, and it represents only six properties of a deposit.

1. The center of the cross indicates the location of the deposit.

2. The color of the long line shows the principal metal, the color of the short line with the arrow shows the secondary metal.

3. The long branch of the cross is the strike; the short branch with the arrow is the azimuth of the dip.

5. The light geological coloring of the map shows the relation between the location of the deposit and the geological structure of the particular region.

7. We again divide this group of deposits into two parts; the larger and smaller ones. The former are represented by the large crosses with the arrow 4 mm. in length, and the perpendicular thick branch equaling the value of the metallic contents in a metric ton of ore (the scale is the same as for the flag-marks of the

map). The latter are represented by small crosses with the long branch equal to 4 mm., and the short branch to 2 mm.

For a graphical designation of the metallic composition of polymetallic ores in the triangle or tetrahedron scheme it is necessary to apply the so-called "bimetallic indices" of an ore.

The number of millimeters in the intercepts *bc, cd, de, ef, fg* gives the relative value of different metals contained in the ore of a deposit. As an example we have five figures for each deposit equal to $\frac{t}{t_0}$, where t is the tenor of the corresponding metal in a given ore and t_0 is the scale-tenor of the same metal adopted for the entire map. Reducing the sum of these five numbers to 100 by means of the proportional diminution or decrease, we have five bimetallic indices of our deposit.

All these methods were successfully applied by me together with Mr. I. F. Grigoriev for the polymetallic ore deposits of Russian Altai.[1] On the map (scale 1 in. = 13.3 miles) there are designated twenty-four of the largest deposits by the use of the flag-marks, 44 by the use of the cross-marks, and 64 of the smallest deposits by means of colored points.

The metallic composition of the deposits is represented on a triangular diagram, on top of which are placed Pb, Zn, Cu. Each deposit is represented by a circle, two colored sectors of which are proportional to the bimetallic indices of Au and Ag for a corresponding deposit.

Pyritic Smelting and Basic Converting at the Kosaka Copper Smelter, Japan

BY KENZO IKEDA*

The Kosaka smelter contains ten blast furnaces, having a maximum daily capacity of 1,600 tons of ore, in which is conducted a slow pyritic smelting without coke or limestone. The 35 per cent matte made is blown to 98.8 per cent in two basic converters, and cast into anodes for the near-by refinery.

Features of the smelter are the abnormally small height of the blast furnaces, the large tuyères, the introduction of coal through the tuyères, a basic lining for the converters (only recently introduced in Japan), and the method of placing this lining.

The blast furnaces vary in design, but the one giving the best results is 24½x4 ft. at the tuyères. The furnace has an open top with sectional sheet-iron covers and a flue on each side. The water jackets are 2.8 ft. square; on each side are seven flat ones with two tuyères apiece, and two curved ones at the corners with one tuyère each. The two end jackets are curved and have no blast openings. Each tuyère is 6 in. in diameter, tapering on its upper side. Opposing tuyères are offset 4 in. on centers. The firebrick lining above the jackets is boshed to a 7 per cent pitch.

Furnace dimensions are: Total height. 17.65 ft.; maximum ore column above tuyères, 9 ft.; tuyères centers to hearth bottom, 3 ft.; area at tuyère level, 98 sq.ft.; total area of the 32 tuyères, 6.3 sq.ft. forehearth, 2x8.5x2.7 ft. deep, inside.

Matte is siphoned continuously into a sand bed at one side, whereas the slag flows into a removable settler, 2x2x2.6 ft., and is then granulated.

The average charge contains 82 per cent of ore, 8.5 per cent of waste rock, 6 per cent of converter slag, 2.5 per cent of revert matte fines, and 1 per cent of flue dust. Of the charge, 45 per cent is briquetted, and 10 per cent is blast-roasted sinter. The large proportion of fine material is successfully smelted largely by reason of the low ore column and weak blast (1 lb. per sq.in.). Chemical analyses are:

	Cu	Fe	Pb	Zn	SiO_2	Al_2O_3	$BaSO_4$	CaO	S	Total
Charge.....	4.1	26	0.5	2.2	26	3.8	4.2	2	25	93.8
Matte.....	24	42	1.5	2.8	..	....	....	..	25	95.3
Slag.....	0.29	30	0.2	2.5	42	6.1	4.6 BaO	3	0.4	88.9

The matte fall is 16 per cent of the charge, or 19.5 per cent of the ore; the slag is 62.5 per cent of the charge, or 76 per cent of the ore.

Feeding coal through the tuyères is one of the unique features of Kosaka and other Japanese practice, and requires considerable skill and long experience. The most suitable coal is a compact non-coking bituminous, high in calorific power and low in ash (18 per cent ash has been found satisfactory at Kosaka). It should be of about nut size, and comparatively dry, though not necessarily so dry as is requisite for pulverizing. The feeding instrument is a metal tube 2 ft. long and 3½ in. in diameter, cut off obliquely at one end; through the other end is inserted a plunger, a disk on the end of a rod. When filled, it holds about 3 lb. of coal. The usual charge at each feeding of a tuyère is 6 to 8 lb., this being repeated at intervals of five to ten minutes. One man usually attends eight tuyères, and can feed about 2,500 lb. in eight hours, at which rate the four men to a shift can feed sixteen tons of coal per day, or nearly 6 per cent of the weight of the charge. The present normal rate is about 4 per cent of the charge, which is about the minimum for a satisfactorily fluid slag.

After feeding a charge of coal, the tuyère is punched; this has to be done carefully to avoid breaking the noses of the tuyères, which normally extend 8 to 12 in. into the furnace and must be clayed up. The coal is introduced just at the point where it will do the most good, and the ability to smelt such an unusually low ore column without any appearance of a hot top is largely the result of this method of supplying fuel. The 6-in. tuyère not only facilitates the coal-feeding operation, but gives greater furnace capacity, easier regulation, and smaller consumption of fluxes and coal.

Basic converting was introduced into Japan at this plant in July, 1920. The old acid shells were remodeled by enlarging the mouth, providing an expansion joint between drum and end plates, and increasing the diameter of the ten tuyères to 1¼ in. Standard 2.5x4.5x9-in. brick, analyzing 80 per cent MgO and 5 per cent SiO_2, were used, set in a mortar composed of fine dead-burned magnesia mixed with one-third its weight of boiler coal tar, to which 1 or 2 per cent of slaked lime had been added to accelerate the setting of the mortar. Between the shell and the bricks was rammed fine dead-burned magnesia moistened with about 7 per cent of its weight of 25 deg. Bé. solution of crude magnesium chloride crystals. The tuyère pipes were embedded in a layer of fine magnesia 18 in. wide and 5 in. deep, wetted with 17 per cent of its weight of 40 per cent water glass.

The converting operation is much like American practice. The converter slag averages: SiO_2, 16 per cent; Al_2O_3, 1; FeO, 40; Fe_3O_4, 32; S, 1; Cu, 3; Pb, 1; and Zn, 3 per cent.

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[1] A. K. Boldirev and I. F. Grigoriev: "Mapping of Ore Deposits. A Map of the Polymetallic Ore Deposits of the Russian Altai." The article is to be published by the Russian Geological Committee.

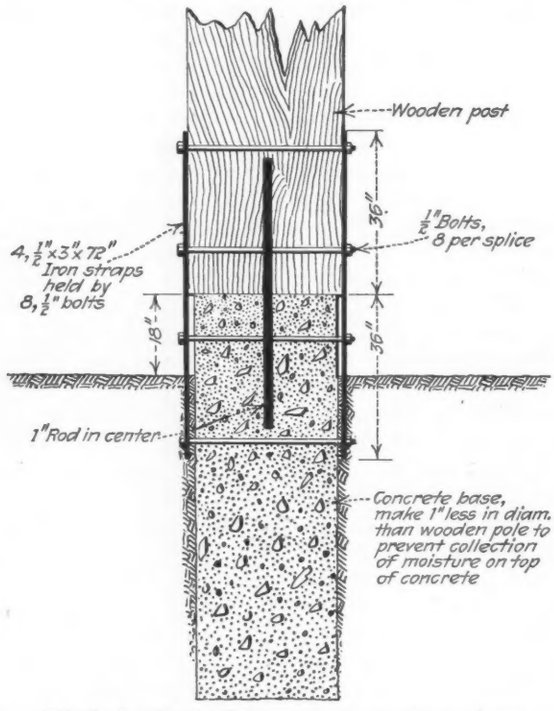
*Abstract of paper No. 1204-N, prepared for the New York Meeting of the A.I.M.E.

USEFUL OPERATING IDEAS

A Concrete Base for Poles

BY ROY H. POSTON

The splice shown in the cut is a good one to use where poles are set in wet ground where the part of the pole below the ground is likely to rot quickly. The concrete base may be used in resetting old poles which


Wooden post
36"
1" Bolts, 8 per splice
4, 1/2" x 3" x 72" Iron straps held by 8, 1/2" bolts
18"
36"
1" Rod in center
Concrete base, make 1" less in diam. than wooden pole to prevent collection of moisture on top of concrete

Method of attaching pole to concrete base

are rotten at the base, or poles may be set thus when just put in. Shorter and therefore cheaper poles may thus be used.

Foundations for Wood Columns

BY JOHN S. WATTS

The useful life of wooden trestles or other wood structures is practically over when the wood begins to decay. As the rot attacks certain parts while the rest is still in good condition, the life of the structure can be lengthened by taking precautions to prevent decay from starting at the most vulnerable points.

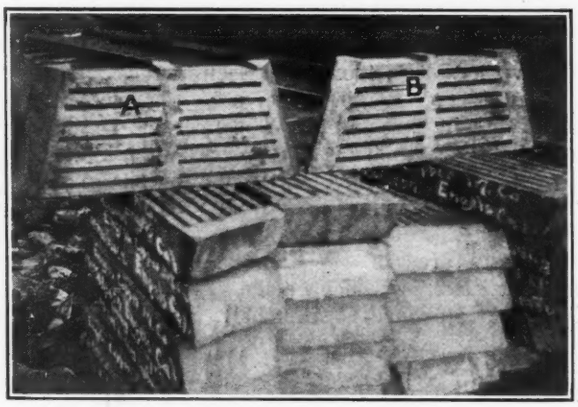
One method of preventing decay has been found satisfactory. The extra expense incurred is trifling. In the top of the concrete is cast a hole about a quarter inch larger than the column, and 1 in. deep. In the center of this hole is a round steel bar, cast in the concrete, and left protruding about 1½ in. When the wood column is bored to receive this bar, and ready for erection, the hole in the concrete is filled with tar, and the column dropped into place. The bottom of the column is thus protected from dampness and hence from decay. The central bar serves to hold the column from being moved sideways, for if the post should move it would break the seal formed by the tar and so permit water to get at the base of the column. In addition to this, care must be taken to have the top of the concrete at least a foot above the ground, and to see that dirt does not accumulate around the posts.

Improved Ball-Mill Screen

BY W. I. NELSON

Considerable trouble has been experienced in the past from the breaking apart of the bars in a ball-mill screen or grid which is made up of bars welded together. Screen sections made up of several bars in a block have been successfully cast and have proved to require practically no repair during the life of the screen. *A* and *B* in the photograph show the front and back faces respectively of the screen sections. The back face is made 3 in. wider than the front, in order that the screens may be held in place with wedge bars. The grid bars are ¾ in. thick on the front face and taper to ⅝ in. thick in the back to prevent blinding by ore particles. Owing to the opposite directions of taper, it has been considered impossible to mold this casting, but the difficulty has been overcome by the Columbia Steel Co., of Portland, Ore., and a year's trial at the Engels Copper Mining Co.'s mill has proved the advantage over the former type of construction.

Breaking apart of the welded bars allowed movement enough to wear off the spacing material and caused blinding in one place and an oversize opening in another, if not entirely releasing some of the bars. The worn condition of the supporting ribs no doubt aggravated the breaking apart of the welded bars, but under the same conditions the saving in repair cost, running time of the mill, and increase in the average of screen area has demonstrated the value of this block-cast type of screen.



Block-cast sections of ball-mill screens.

CONSULTATION

The Future Price of Lead

"I wish to thank you for the statement showing changes that have been made by various acts of Congress since 1883 in assessing duty on lead.

"It is the opinion of mining men in the West that the price of lead will average higher in the future than in the past. They base their reasoning for this on the fact that the telegraph and telephone wires in the cities are all going underground in lead cables, and that the consumption of lead in automobile batteries is permanent and is an entirely new addition to lead consumption; also, the consumption for paint will continue at a rate equal to if not greater than at any time in the past.

"I am much interested in this matter, for the reason that the Revenue Department has fixed the price of lead at 4½c. for use in valuing mines, and in case it is necessary to value a new mine under the discovery clause of the income tax law, if the average price of lead is to rule at a higher level in the future than in the past, the Treasury Department should recognize the fact.

"Men in a position to know have advised me that it is impossible to produce lead at a cost equal to the old figures prior to the war, and they do not see any hope of getting costs down to anywhere near the pre-war level; so that, should the demand fall off sufficiently to bring the selling price down, the high-cost producers would have to close up, thereby forcing the price of lead up again. This same line of reasoning was pursued a few years ago in the matter of copper, but it apparently did not work out, due to the fact that the copper producers, instead of closing up when the price of the metal went below cost, kept on producing and stored their product; also, the European market was partly lost.

"I am inclined to believe that the automobile industry has nearly reached the saturation point, or, at least, the buying power of the people in the United States has about been reached, so that in the future sales will be more in the nature of replacements. This, of course, would not result in any decrease in the use of lead for batteries, as it would be necessary to use batteries regardless of whether or not the car was new or old.

"However, the matter is interesting, and I am wondering whether or not the reasoning for a high average price of lead in the future is sound."

Another exceedingly important reason for believing that the price of lead may continue at a higher level than before the war is that no large lead mines, with the exception of the Burma mines in Asia, have been developed in the last eight or ten years. Lead is fortunate in having an exceptionally diversified consumption, and the demand for it seems to be widening. This fact, coupled with the possibility of having a smaller world supply in the future, is sufficient to make lead producers optimistic. All these conjectures are, of course, subject to change by unforeseen circumstances.

The Market for Zirconium and Titanium

"Can you tell me what quantity of zirconium and titanium is produced in the United States and whether or not these metals have a ready sale and what the market price is of each; also whether zircon is associated with other metals or is produced by itself?"

Zirconium minerals have not been produced commercially in the United States for many years. They occur in the country, however, and small and negligible amounts are occasionally found and mined. On the other hand, generally several hundred tons of titanium-bearing minerals, chiefly rutile and ilmenite, are produced annually in the United States, but in 1921 no production was reported. We do not believe that the production of metallic titanium and zirconium has passed beyond the experimental stage, as the chief uses for the minerals from which these metals are extracted require the consumption of the minerals themselves. Thus, zircon is used in the manufacture of highly refractory brick and other products of high fusing points, and titanium minerals are used in the manufacture of ferrotitanium, a ferro-alloy employed in steel production. Quotations covering the current value of zircon and titanium minerals, together with a few of their manufactured products, will be found in the market section.

Zircon is generally found in association with heavy black sands in the South, but it also occurs disseminated in the more acid igneous rocks, especially granites and syenites. Metamorphic rocks may contain it.

Marketing a Lead-Vanadium Ore

"I wish to inquire if you can advise me where I may find a market for an ore a sample of which shows it carries the following metals:

Silver, oz.	1.30	Lead, per cent	15.15
Gold, oz.	.19	Vanadium, per cent	2.90

"This sample was taken from the ore dump on a prospect I am developing in Kern County, Calif. Have about twenty tons of ore on the dump and a good strong oreshoot about two feet wide in a vein about twelve feet wide. My pannings show this ore concentrates easily. I will greatly appreciate any information you may be able to give me as to a probable market for this ore."

It is a difficult problem to market a complex ore of this character. Lead smelters do not care to handle the vanadium, which they consider an impurity, and vanadium producers might contend that the vanadium content is too low for their use. Although it is not so stated, the lead and vanadium are probably intimately associated in the ore, making separation of its constituents difficult if not impossible. Concentration and marketing of the separated products is the ideal solution, but may not be feasible for other reasons. Vanadium is a valuable metal, being worth about $1 per lb., so that the vanadium content of the ore in question is worth about $58 per ton, against $25 per ton for the lead content. This would indicate that a greater effort should be made to sell the product as a vanadium ore than as a lead ore. However, such calculations are more or less theoretical, and the proof of the pudding is in the eating. The price that can be obtained had best be ascertained from communication with smelters prepared to handle the ore. As the ore stands it is doubtful if it can be profitably marketed unless both the vanadium and lead are paid for.

THE PETROLEUM INDUSTRY

The Origin of Salt Domes

A Chronological Tabulation of Theories Thus Far Advanced —Mystery as to Formation May Be Solved Through Deeper Drilling

BY ALBERT G. WOLF
Mining Engineer, Gulf, Texas

SALT-DOME formations of the Texas and Louisiana Gulf-coastal region of the United States produced, in 1921, over 99 per cent of the sulphur output of this country, nearly 8 per cent of the petroleum, and an appreciable portion of the salt. These domes, then, are of great economic importance, and their origin is of considerable scientific interest. Though a great deal has been written on this subject, it certainly has not been exhausted. It is unlikely, however, that much new material will be added to the fund of public knowledge until such time as the big oil companies see fit to disseminate information regarding oil geology as freely as do the large mining companies in the field of mining geology.

The purpose of this article is not to expound any new theory on the origin of salt domes, but to tabulate, in chronological order, concurrently with notes on the development of the various domes, the different theories that have already been advanced. It is believed that this will afford a ready reference to those who wish to study this subject in all its details.

Long before the discovery of rock salt in place, "salines" or salt springs, salt marshes, and the like were known on the Gulf coast of Louisiana and Texas, and the salt was put to commercial, or, at least, domestic use. These salines were the inspiration of possibly the first article leading up to the subject under discussion. The date of publication and the title of this article were as follows:

1860. Bedded deposits from the evaporation of sea water by volcanic heat. Thomassy, R.: "Geologie pratique de la Louisiane, Chap. 8, Paris, 1860; "Supplement à la geologie pratique de la Louisiane, Ile Petit Anse": Soc. Geol. de France, Bull., 2d ser., 1863, Vol. 20, pp. 542-544.

The first discovery of a solid rock-salt core, which is present in every coastal salt dome, was made at Avery Island, Iberia Parish, La., about 1862. Salt had been made from brine at this place for over fifty years previously, but at the time mentioned, on account of the greatly increased demand for salt, due to the Civil War, an attempt was made to increase the output by deepening a brine well. This resulted in the finding of rock salt in place.

At about this same time the first discovery of oil in a dome formation was made at Saratoga, Hardin County, Tex. Here shallow drilling, it is stated, resulted in the finding of a small quantity of heavy black oil. Drilling was not continued deep enough to disclose the true nature of the structure, and the first important oil well was not completed until 1901.

In 1865, drilling for oil near Bayou Choupique, Calcasieu Parish, La., was done, and porous limestone containing sulphur in quantity and anhydrite were found. These rocks were later known as the cap rock of the salt dome, and this particular dome was called Sulphur, a suitable name for one of the largest sulphur mines in the world.

It is only natural that after these interesting discoveries considerable should be published about the deposits, and the following theories were advanced regarding the origin of the structures:

1865. Bedded deposits from the evaporation of sea water in shallow lagoons. Owen, R.: "Report on the Quaternary Rock Salt Deposits in Louisiana," St. Louis Acad. Sci. Trans., Vol. 2, p. 250, 1868.

1867. Secondary deposits from ascending artesian waters. Goesmann, C. A., and Buck, C. E.: "On the Rock Salt Deposits of Petit Anse, Louisiana Rock Salt Co.," Rept. of Amer. Bureau of Mines, New York, 1867.

1869. Cretaceous monadnocks. Hilgard, E. W.: "On the Geology of Lower Louisiana and the Rock Salt Deposit of Petit Anse," Amer. Jour. Sci., 2d ser., Vol. 47, p. 77, 1869; "On the Geology of Lower Louisiana and the Salt Deposits on Petit Anse Island," Smithsonian Contributions, Vol. 23, Separate as No. 248, 1881.

The next step in the development of the salt domes was the discovery of oil, about 1893, in some shallow wells at Sour Lake, Hardin County, Tex. None of the wells drilled at this time was more than 400 ft. deep, and the quantity of oil obtained was insignificant. It was not until 1901 that deeper drilling was done here, oil in quantity found, and the true nature of the dome disclosed. At this time a new theory of the formation of salt domes was offered:

1893. Cretaceous monadnocks. Lerch, Otto: "A Preliminary Report on the Hills of Louisiana," Louisiana State Experimental Stations, Geology and Agriculture, Vol. 1, p. 27, and Vol. 2, pp. 53-109, 1893.

1895. Cretaceous outlier. Clendenin, W. W.: "A Preliminary Report Upon the Florida Parishes of East Louisiana and the Bluff, Prairie and Hill Lands of Southwest Louisiana," Louisiana State Experimental Stations, Geology and Agriculture, No. 3, pp. 236-240, 1896.

SULPHUR MINING BY FRASCH PROCESS BEGUN

Considering that there are approximately sixty salt domes in Louisiana and Texas, that many of them are topographically prominent, and that now a score or more of these domes are oil producers, it seems more than passing strange that before oil in commercial quantity was found in any dome, an epoch-making method of mining sulphur should have been devised and put

into application. But such is the fact. In 1891, Herman Frasch conceived the idea of melting the sulphur in the great deposit discovered at Sulphur, Calcasieu Parish, La.. by means of superheated water and pumping the mineral to the surface in the liquid state. By 1895 the process was in operation. This method, now in use at the world's three greatest sulphur mines, those of the Texas Gulf Sulphur Co., at Gulf, Tex., the Union Sulphur Co., at Sulphur, La., and the Freeport Sulphur Co., at Freeport, Tex., has given to the United States domination of the sulphur industry of the world, and made the coastal salt domes of greater economic importance and scientific interest than the oil production alone could have done.

There now entered into the exploitation of the salt domes one who did more than any other man to bring these peculiar geological formations into prominence, namely Capt. A. F. Lucas. In the summer of 1896 he took charge of the drilling that resulted in the discovery of the salt core at Jefferson Island (Cote Carline), in Vermilion and Iberia parishes, La., and went far toward showing the great depth to which these cores extend. Later, in the same year, he began drilling at Belle Isle, St. Mary Parish, La., another of the "Five Salt Islands," as they later became known, and in 1897 discovered the great salt mass there.

Lucas Gusher Brought In

Contending that Spindle Top, a slight topographic eminence in Jefferson County, Tex., indicated the presence of a dome, and, hence, a favorable formation for the collection of oil, Lucas proceeded to drill there in 1900, and on Jan. 10, 1901, brought in the great Lucas gusher, which had an estimated initial production of 75,000 bbl. daily. Immediately there followed a widespread drilling campaign. Many of the more topographically prominent domes were prospected, including, in Texas: Barbers Hill, Chambers County; Big Hill, Matagorda County (now the Texas Gulf Sulphur Co.); Bryan Heights (now the Freeport Sulphur Co.), Damon Mound and West Columbia, Brazoria County; High Island, Galveston County; and Pierce Junction, Harris County; and deeper drilling was done at Saratoga and Sour Lake. In Louisiana, work was started at Hackberry, Cameron Parish, and at Jennings and Vinton, Calcasieu Parish.

The first deep oil at Sour Lake and Jennings was found in 1901, but gusher oil was not found at either place until the following year. That same year deep oil was discovered at Saratoga and Vinton, although Vinton did not become a producer of prominence until 1910. By this time considerably more geological information had been gathered and a new theory of origin was advanced:

1902. Secondary deposit; uplift due to pressure of ascending artesian waters. Hill, R. T.: "The Beaumont Oil Field," Journal of the Franklin Inst., Vol. 154, p. 263; 1902.

Batson, Hardin County, Tex., was brought in during 1903, and oil at Blue Ridge, Fort Bend County, Tex., was also discovered that year. There followed another theory:

1903. Secondary deposit from ascending magmatic waters. Coste, E.: "Volcanic Origin of Natural Gas and Petroleum," Canadian Mining Inst. Jour., Vol. 6, pp. 73-123; 1903.

In the following year Humble, Harris County, Tex., the largest oil producer of the coastal pools to date, was brought in. About this time the following theory was offered:

1904. Uplift due to igneous plug. Hager, Lee: "The Mounds of the Southern Oil Fields," *E. & M. J.*, pp. 137, 180, July 28, 1904.

Oil was found at Hoskins Mound, a prominent surface uplift in Brazoria County, Tex., and at North Dayton, Liberty County, Tex., during 1905. A little later a combination theory was suggested:

1906. Secondary deposit from ascending magmatic waters; uplift due to igneous plug. Veatch, A. C.: "Geology and Underground Water Resources of Northern Louisiana and Southern Arkansas," U. S. Geological Survey *Professional Paper* 46, p. 29, 1906.

No Salt Core Found in Goose Creek Field

No dome fields were discovered in 1907. The prolific Goose Creek field was brought in during that year, but it cannot be truly classified as a salt-dome field, because the salt core has never been found there. This absence of salt core is also true of Jennings and Edgerly, in Louisiana, and Orange, in Texas. A new uplift theory, however, was advanced this year, quite distinct from all foregoing ones:

1907. Secondary deposit from ascending artesian waters; uplift due to force of growing crystals. Harris, G. D.: "Rock Salt in Louisiana," Louisiana Geol. Surv. Bull. 7, p. 76, 1907; "The Geological Occurrence of Rock Salt in Louisiana and East Texas," *Econ. Geol.*, Vol. 4, pp. 21-23, 1909.

Prospecting in the Hull field, Liberty County, Tex., started before 1907, but the first well was not completed until 1908. In this latter year the first producing well at Markham, Matagorda County, was also brought in, and Big Hill, in this same county, was drilled for the sulphur that had been discovered in oil-well drilling from 1901 to 1903. Sulphur production here, however, did not start until 1919, under the Texas Gulf Sulphur Co.

Most Salt Domes Discovered by 1908

By the end of 1908 almost all the salt domes known today had been discovered, although several of the domes had not then proved to be productive, and some are still unproductive. New theories regarding the origin of these domes continued to appear. Two years later one of the most revolutionary and yet quite plausible, in regard to the formation of the European domes, was published by a German geologist:

1910. Intrusion of salt caused by lateral pressure due to folding of strata at depth containing salt beds. Harbort, E.: "Geologie der Nordhanovierschen Salz Horste," Monatsberichte Deutschen Geologischen Gesellschaft, p. 334, 1910.

Development of the sulphur deposit at Bryan Mound was undertaken in 1911. This dome had been discovered in 1901, but the exploitation of the sulphur was left until this year. In the following year a variation of Harbort's theory was advanced by two other German geologists, Arrhenius and Lachmann:

1912. Intrusion of salt in semi-plastic condition from underlying bedded deposit caused by pressure of overlying sediments. Arrhenius, S.: "Zur Physik der Salzlagerstatten," Medel. Frau Vet-Akads. Nobelinstitute, Bd. 2, No. 20, 1912; and Lachmann, R.: "Studien über den Bau von Salzmassen," Kali Zeitschrift, Vol. 6, pp. 342, 366, 398, 418, 1912.

Now follows a series of new theories, one or more a year for several years:

1913. Intrusion of salt in molten condition, due to igneous activity. Turrentine, J. W.: "The Occurrence of Potassium Salts in the Salines of the United States," Bureau of Soils Bull. 94, p. 43, 1913.

1914. Secondary deposits from ascending artesian waters, uplift due to growing crystals, salt deposited by mass action of other chloride solutions of magmatic origin. Washburne, C. W.: "Chlorides in Oil Field Waters," *Trans.* A.I.M.E., No. 48, pp. 687-694, 1915.

1915. Thermal spring deposits. Norton, Edward G.: "Origin of Salt Domes," A.I.M.E. Bull. 97, pp. 93-102, Jan. 1915.

1916. Uplift due to vertical thrust from below, force deep-seated. Hopkins, Oliver B.: U.S.G.S. Bull. 661-G, p. 264, 1917.

1917. Uplift due to force of growing crystals, deposition of salt due to drying effect of expending gas. Mills, R. V. A., and Wells, R. C.: "The Evaporation of Water at Depth by Natural Gases," abstract Washington Acad. Sci. Jour., Vol. 7, No. 10, p. 309, 1917; U.S.G.S. Bull. No. 693, "The Evaporation and Concentration of Waters Associated With Petroleum and Natural Gas," 1919.

1917. Bedded deposits in salt lakes. Kennedy, William: "Coastal Salt Domes," Southwestern Association of Petroleum Geologists, Bull. 1, p. 34, 1917.

The year 1918 saw the discovery of oil at Damon Mound and the bringing in of the deeper oil wells at Hull. During this year four new theories came forth:

1918. Uplift due to laccolithic intrusion at depth. Lucas, A. F.: "Possible Existence of Deep-Seated Oil Deposits on the Gulf Coast," A.I.M.E. Bull. 139, p. 1119, July, 1918.

1918. Intrusion of salt in semi-plastic condition from bedded deposits below, pressure due to lateral or compressive thrust. Rogers, G. Sherbourne: "Intrusive Origin of Gulf Coast Salt Domes," *Econ. Geol.*, Vol. 13, No. 6, p. 467. Sept., 1918.

1918. Intrusion of salt in semi-plastic state from bedded deposits below, pressure due to weight of overlying rocks, together with recrystallization. De Golyer, E.: "The Theory of Volcanic Origin of Salt Domes," A.I.M.E. Bull. No. 137, p. 1000, May 1919.

1918. Domes are the result of organic action at different times, movements probably the result of isostasy. Dumble, E. T.: A.I.M.E., September meeting, 1918.

Blue Ridge was developed in 1919. In 1921, deep oil was discovered in the Pierce Junction field. Both of these domes, as stated before, had long been known, but it required many years of prospecting to find the oil "pool." During this latter year the last two theories, and the latest, so far as I have been able to determine. were extended:

1921. Salt beds folded and thickened at crests of anticlines. Emmons, W. H.: "Geology of Petroleum," 1st Edition, 1921.

1921. Secondary deposits from hot ascending solutions, uplift due to later lateral pressure. Matteson, W. G.: "Secondary Intrusive Origin of Gulf Coast Salt Domes," *Mining & Metallurgy*, Feb., 1921.

The latest actual discovery of a salt dome was made in February, 1922, when the Gulf Production Co. struck the salt core at Big Creek, Fort Bend County, Tex., at the comparatively shallow depth of 720 ft.

On Nov. 28, 1922, the No. 4-B Kishi Lang well of the Gulf Production Co. at Orange, Tex., began making oil from a depth of 5,489 ft. This is the deepest well on the Gulf Coast, and is said to be the deepest oil-producing well in the world. Perhaps the mystery of the formation of our coastal salt domes will be solved through deeper drilling.

Oil Development in the West Indies During 1922

Crude oil is produced commercially in only two of the West Indian Islands (exclusive of Trinidad), namely Cuba and Barbados, according to Arthur H. Redfield, in a paper presented at the recent meeting of the A.I.M.E. in New York. Statistics of production for both islands are incomplete. In Cuba, production has decreased from 19,167 bbl. in 1917, to an estimated output of 20 bbl. a day. A new and productive well was opened up in Barbados in 1922, but no figures of its output are available. The production of Barbados is estimated at 150 bbl. a day. No activity was reported from Haiti. Drilling continued in the Dominican Republic, but no production was obtained.

The West Indies, as discussed in this paper, include principally the Bahamas, Cuba, Jamaica, Haiti, Porto Rico, the Virgin Islands, the British Leeward and Windward Islands, Barbados, Martinique, Guadaloupe and dependencies, and the Dutch Islands of the southern Leeward group. Trinidad and Tobago are excluded. All of the West Indies, as thus defined, except Curacao, depend on imports to satisfy their requirements of refined products of petroleum.

In Cuba, the Union Oil Co. continued its operations at Bacuranao, in the Province of Havana. Since the opening of this field in 1916, it has produced about 100,000 bbl. of oil. At the end of 1921, the wells were producing only about 20 bbl. a day. The company drilled, during 1922, on other concessions situated about 3 km. from the old wells, but apparently without success. The Rosario Petroleum Co., said to be affiliated with the Standard Oil Co. of New Jersey, has begun drilling at Taco Taco, Province of Pinar del Rio. The well had reached a depth of 3,000 ft. by mid-summer. No further details concerning the well are known.

In Haiti, there are no producing oil fields and no test wells have been drilled. Though a number of permits for prospecting were issued during 1919 and 1920, none of the holders had availed themselves of their privileges by the end of 1922.

In the Dominican Republic the Santo Domingo Development & Investment Corporation continued operations on its concession at Higuerito, drilling twenty-four hours a day, with two shifts. No oil has been reported to have been found.

In Barbados, in March, 1922, the British Union Oil Co., Ltd., which has the exclusive concession to search for oil there, struck oil at a depth of 2,100 ft at Turners Hall, in the northern part of the island. This is the second producing well of any consequence brought in. The petroleum is said to be of a paraffine base, with a high gasoline content and a low flash point. The company has eleven or twelve wells in operation, from which it obtains about 150 bbl. a day. The company is planning deeper drilling.

In Curacao, in 1921, the refinery of the Curacaosche Petroleum Maatschappij (Royal Dutch) at Willemstad was said to be working at three-fourths capacity. In 1922, the refinery reached its full capacity, as is indicated by the increase both in imports of crude oil and exports of refined oils, and by re-exports of surplus crude oil to the United States to be refined.

More crude oil was imported into Curacao during nine months of 1922 than during any preceding year, equaling 221,213 metric tons, compared with 130,035 tons in the corresponding months of 1921.

NEW BOOKS

Mining Engineering as a Career

Interviews With Mining Engineers. By T. A. Rickard. *Mining & Scientific Press*, San Francisco, Calif. Price, $3.

This book should be of absorbing interest to anyone who has been, is, or aspires to be a mining engineer. One might go farther and recommend it to a young man who was debating the question of whether to aim at being a mining engineer or to try something else. It might cause him to abandon the idea or inspire him to pursue it ardently—at any rate it would give him a fair knowledge on which to base his decision. The book contains the record of twenty-four interviews with representative engineers. The questions were propounded personally by Mr. Rickard and the answers are given with little editing from the record prepared by a stenographer. Literary polish has been sacrificed for genuineness. It has been said that the history of the world could be told in the biographies of fifty men. Likewise this book gives an excellent, though of course disconnected, history of metal mining in the last forty years. It does more than outline the careers of these twenty-four engineers; it reflects the tendencies in technical advance, in economic development, and in social progress in the mining industry.

More important than the bare facts that it recounts are the opinions and the ideals that it records. A feature is the appreciation that accompanies each interview; Mr. Rickard has taken the opportunity to say a few complimentary things that modesty prevented from creeping into the interviews.

Of the engineers themselves it may be said that among them are numbered some of the most successful of the present generation as measured by financial prosperity, by professional achievement, and by prominence in the industry. Some have become neither wealthy in world's goods nor prominent in their profession, but their careers are among the most interesting for the reason that they have contributed something of constructive value to the mining industry, and, it is not too much to say, to the progress of the world at large.

A. B. PARSONS.

Before Civilization Hit Siberia

The Last Stand of the Old Siberia. By R. A. F. Penrose Jr. William F. Fell Co., publishers, Philadelphia.

This beautifully printed little book is a narrative based on a geological and geographical reconnaissance trip made by the author in 1901, just after the Boxer war in China. The manuscript was written in the same year, but was not published till 1922, when the author was urged to print it as a matter of historical record. Soon after the period of which it treats, Siberia "began to shuffle off its mediaeval aspects and to assume more modern methods and appearances. Whether or not this was for the better is a matter for discussion, but it always seems sad to see nature trammeled by the blighting aggressiveness of man."

The narrative "relates to the last stand of the old Siberia, just before it was engulfed in the upstarting new Siberia, and this history may be of interest to some as describing the conditions in the world's greatest and most glorious wilderness as it met the fanatical onrush of selfish and relentless humanity advancing under the name of modern civilization." As such, this little volume will be a valuable record.

J. E. SPURR.

A Directory of 10,000 Engineers

Who's Who in Engineering—1922-1923. John W. Leonard, Editor. John W. Leonard Corporation, 375 Fulton St., Brooklyn, N. Y. Price, $10.

Unique is a word to use with discrimination, but it can be applied to this book without hesitation. No one has ever before tried to prepare a comprehensive directory of engineers. This volume is more than a directory, for it contains brief biographies and the professional record of 10,000 members of the various engineering professions. Some men whose prominence and reputation warrant their inclusion in the book have been left out, and some men of comparative obscurity have doubtless worked themselves in, but the net result is to be commended from every standpoint. The book should prove of interest to every engineer, and to those whose business requires a directory of engineers it is indispensable.

Metal Marketing

The New York Metal Exchange. A pamphlet of 24 pages published and distributed by the New York Metal Exchange, 111 Broadway, New York City.

This brief but interesting booklet describes the machinery of the New York Metal Exchange. General rules and regulations, and special rules governing trading in tin, copper, lead, and zinc are given in great detail. Typical contract forms are included for transactions in each of the non-ferrous metals, and these increase the value of the compendium. The purpose of all this is frankly to widen the scope of the exchange, so that it may become a more important agency in the buying and selling of metals. All its cards are placed on the table. The facilities are there, and a willingness is shown to give every reasonable accommodation to traders in the metals. It is no fault of the Metal Exchange that a larger volume of business is not handled on its floor. The exchange expresses a willingness to send this booklet to all our subscribers interested in the metal markets. It will be mailed free of charge, on application.

F. E. WORMSER.

SOCIETIES, ADDRESSES AND REPORTS

Newton Heads Idaho Mining Asssociation

Dennison "Blue-Sky" Bill Opposed—Move to Aid Gold and Silver Producers Endorsed

C. W. Newton was elected president of the Idaho Mining Association at its tenth annual convention in Boise recently. J. B. Eldridge was chosen vice-president and Ravenel Macbeth re-elected secretary. The following were appointed as executive committee: I. E. Rockwell, James F. McCarthy, W. N. Sweet, F. E. Johnesse, and Robert N. Bell.

A bill introduced at Washington, which provides for the appointing of a joint commission to enquire into the gold and silver situation, was indorsed. It provides that the commission shall report to Congress on the methods and means of stimulating the production of gold and the stabilization and wider use of silver.

A resolution was adopted opposing the proposed Dennison "blue-sky" law which is now before the United States Senate. It was held that the passage of the bill would be detrimental to the mining industry.

Protest against the proposed measure that is now before the State Legislature providing for a change in the methods of taxation employed for mines was voiced by the association on the ground that, if passed, the law would be detrimental and destructive to the mining industry of the state. It was set out in the resolution that such a law would greatly aid in the suspension of mining development and operation and would cause the withdrawal of capital from investments. The law now on the statutes was indorsed.

It was proposed that the salary of the mining inspector be increased to the basis on which other state officials are paid.

Indorsement for the bill now before the Legislature asking for a $30,000 appropriation for the continuation of the State Bureau of Mines and Geology was voted.

Montana Section of A.I.M.E. Elects New Officers

A joint meeting of the Montana Section of the A.I.M.E. and the Montana Society of Engineers was held recently at Anaconda at the Silver Bow Club. New officers were elected by the former society as follows: Reno H. Sales, chairman; E. V. Daveler, vice-chairman; E. B. Young, secretary; and J. L. Bruce and J. J. Carrington trustees.

F. A. Linforth read a paper entitled "Some Applications of Geology to Mining." E. A. Barnard spoke on "Development of the Production of Arsenic," describing the various steps required to put that commodity on the market 99.9 fine.

MEN YOU SHOULD KNOW ABOUT

Joseph Irvington is in Mexico.

Philip R. Bradley has gone to Idaho.

William Kemp, of Tucson, Ariz., is in San Francisco on mining business.

W. Lee Heidenreich, who has been in Cuba for several months, has returned to the United States.

George Hooper has resigned as general manager of the Victoria Copper Mining Co., at Victoria, Mich.

B. Getzoff, president of the Stargo Mines, Inc., has returned to Clifton, Ariz., after a visit to New York.

Leonard Worcester has returned to El Paso from Cusihuiriachic, Mexico, where he has been examining silver properties.

J. P. Porteus, superintendent of the Bonney Mining Co., at Lordsburg, N. M., has returned to the mine from San Francisco.

Louis Garbrecht is now at Torreon in the employ of the Penoles Co., the Mexican branch of the American Metal Company.

Eugene Dawson, who has been examining properties in Georgia during the last few weeks, has returned to New York.

Charles Butters has gone to Nicaragua for the purpose of supervising the installation of equipment at the San Albino mine.

Henry C. Carlisle will make his headquarters at the Gadsden Hotel, Douglas, Ariz., while making examinations in northern Sonora, Mexico.

W. D. Trethewey, the Cobalt mine owner, who some years ago went to reside in England, has given up his home there and is returning to Canada.

J. H. Trerise, of Los Angeles, has completed his examinations of copper properties in the Lordsburg, N. M., district, and is at Arispe, Sonora, Mexico.

M. G. Heitzman, for the last several years engineer at the Silver King Coalition Mines Co., at Park City, Utah, has been advanced to the position of mine superintendent.

Fletcher Hamilton, who recently resigned from the office of State Mineralogist of California, will open an office in San Francisco and practice as a mining and petroleum engineer.

Norman Carmichael, formerly general manager of the Arizona Copper Co., is spending a few days in Globe, Ariz. He will return to the corporation headquarters in New York.

F. H. Stover, who has been in charge of the drilling operations of the Fort Norman Oil Co. in the Mackenzie River district, is in Edmonton arranging for this season's drilling program.

B. W. Batchelder, general manager of mines for the Wisconsin Steel Co., with headquarters at Nashwauk, Minn., has left for a business visit to the company's coal properties in Kentucky.

H. W. Chadbourne, of New York, who is interested in gold mining properties in Rouyn Township, Quebec, is in Toronto in connection with plans for an extensive development campaign.

Frank Armstrong, a member of the firm of Pickands, Mather & Co., was a recent visitor to the Zenith Furnace Co., at Duluth, Minn. Mr. Armstrong makes his headquarters in Cleveland.

Oscar C. M. Bilharz

P. G. Beckett, general manager for the Phelps Dodge Corporation who hurried to Dawson upon receipt of news of the recent coal-mine disaster there, has returned to headquarters at Douglas, Ariz.

Dr. Hubert Work has been transferred from the office of Postmaster General to become Secretary of the Interior, succeeding Albert B. Fall, whose resignation is effective on March 4.

S. R. Elliott, general superintendent of the Cleveland-Cliffs Iron Co., at Ishpeming, Mich., was a recent visitor to the Mesabi iron range, where he made a trip of inspection to the company's properties.

F. M. Feiker, vice-president of the McGraw-Hill Co., on Feb. 13 addressed the Pittsburgh Advertising Club on "The Importance of Reliable Technical and Trade News to the American Business Man."

P. B. Butler, of Joplin, Mo., district manager for the Barnsdall Zinc Co., a subsidiary of the Barnsdall Corporation, has returned from a trip to Mexico, where he inspected the company's property near Parral.

Forrest Mathez, who for a number of years has been in close touch with mining affairs in the state of Utah, will open an office in Salt Lake City as consulting engineer and at the same time look after his numerous personal interests.

Orrin P. Peterson, of Hinsdale, Ill., has recently completed an extended engagement at Pachuca, Mexico, for the Real del Monte Co. in organizing a geological department and in making geological investigations of all the company's properties. He is now on his way to Panama to examine several concessions there.

Mining and metallurgical engineers visiting New York City last week included: **W. F. Bitler**, of Swarthmore, Pa.; **G. R. Elliott**, of Tulsa, Okla.; **Edwin J. Collins**, of Duluth, Minn.; **Spencer R. Logan**, of Washington, D. C.; **J. Whitney Lewis**, of Los Angeles; **B. M. O'Harra**, of Rolla, Mo.; **C. F. Jackson**, of Cleveland, and **J. H. Rodgers**, of Canon City, Colo.

OBITUARY

Carlos Warfield, one of Augustus Heinze's adjutants, died in Montreal, on Feb. 17. Like Mr. Heinze, with whom he was associated in the early days of Porcupine, Ontario, Mr. Warfield was a somewhat picturesque character, reminiscent of older methods in mining speculation. He was born at St. Joseph, Mo., and was intimately associated with Butte, British Columbia and Ontario mining developments.

Oscar C. M. Bilharz, mining engineer and mine owner, died on Feb. 2. He was born in 1863 in the neutral territory of Moresnet, a small tract of land about a mile square, lying between Belgium, Holland and Germany, where his father held the position for a period of twenty-five years of consulting engineer and manager for the Vielle Montagne Zinc Mines. He first received a general education in the "Gymnasium" and University at Aix la Chapelle, Germany, later taking his technical training at the famous old school of Mines at Freiberg, Saxony, where his degree of mining engineer was conferred. His first practical experience was gained in England, Scotland, and Greece, and then he was sent on consulting work to Alaska and California. About 1893, Mr. Bilharz began the application of his technical knowledge with the St. Joseph and Doe Run lead companies, in the southeast Missouri district. He remained there for twenty years, finally assuming full charge of the entire operations of the combined companies. At the beginning of the great mining growth in the Oklahoma-Kansas-Missouri zinc fields, he acquired and entered into the development of valuable holdings in Oklahoma, with Victor Rakowsky, of Joplin, Mo. Again applying his large engineering experience, he brought these properties into successful operation, and until his death was constantly enlarging his field of endeavor. Mr. Bilharz was a member of the American Institute of Mining and Metallurgical Engineers, the American Zinc Institute, and the American Mining Congress.

THE MINING NEWS

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Leading Events

GOLD BULLION valued at $12,274,114 was produced by the Hollinger Consolidated Gold Mines during the year 1922, according to the report soon to be issued. Ore was mined and milled at a cost of $4.255 per ton.

Michigan copper producers prepare to increase wages to compete in the labor market for enough miners to increase their output to normal.

The Colorado Corporation is pushing construction work at Rawley, Colo.

Copper mining will be started by the Butte & Superior company at Butte.

State legislatures in Arizona, Colorado, and Washington struggle with various measures that seem burdensome to mining interests. To date few have been passed, however.

The Engels Copper Co. realized a good operating profit in 1922.

Mills continue to "sprout" in the Tri-State zinc-lead fields.

United Verde production cost is given as 12.67c. per pound of copper by H. DeWitt Smith, superintendent.

Development of oreshoots below No. 4 Tunnel of the Premier Mine in British Columbia encourages neighbors.

Hollinger Produced $12,274,114 in Bullion During 1922

Record for Gold Mining in North America—Operating Cost $4.255 Per Ton Milled—Power Problem Serious

IN ITS EVERY DETAIL the twelfth annual report of Hollinger Consolidated Gold Mines, of Porcupine, Ontario, confirms the confidence of the directorate and the optimism of the management. Not only are the results unprecedented in gold mining on this continent, but the developed and indicated ore reserves are greater than a year ago. The results may be summarized:

	1922	1921
Tons milled	1,491,381	1,072,493
Average value	$8.53	$9.67
Gross value	12,726,549.77	10,367,901.07
Loss in tailings	452,435.00	336,850.50
Net value recovered	$12,274,114.77	$10,031,050.57
Operating cost per ton milled	$4.255	$4.8698

A compensating factor for the seeming lowering of the grade of the tonnage milled, by $1.14, was the lowering of the working cost, by 61.47c. When it is also recalled that in 1921 the greater premium on New York funds amounting to 93c. per ton was carried in current operations, the per-ton operating profit of $4.27, as compared with $4.80 in 1921, bespeaks the efficiency of operations, considering that there were power interruptions in the earlier and final weeks of the year.

Assuming the 509,380 tons of broken ore in the mine on Dec. 31, to have a gross value of $4,500,000, the ore reserve position at the end of the year follows:

	1922 Tons	1922 Estimated Value	1921 Tons	1921 Estimated Value
Total ore reserves	3,390,745	$35,737,873	3,402,609	$36,644,154
Probable ore in veins, under $6	1,007,797	5,348,594	787,668	4,162,833
Surface deposits	209,681	2,183,360	202,640	1,909,040
Grand total	4,608,223	$43,269,827	4,392,917	$42,716,027

The average value per ton of the reserves is $9.39, compared with $9.72. It may be said that after yielding approximately $60,500,000, the mines have $29,065,425 assured above the 800 level. A third of the ore milled in 1922 came from above the 425-level. Only 33,918 tons came from below the 800. Not only have the reserves been more than maintained but General Manager Brigham states: "Throughout the year the development has been highly favorable, particularly on levels 950, 1,100, and 1,250, where all veins so far exposed are of good widths and values, as compared with the occurrences on the upper horizons. As shown in the statement of ore reserves, the important increases in tonnage are in veins of medium grade tenor. During the coming year a considerably larger expenditure on development account will be necessary to provide for the increased milling program."

In this latter connection Mr. Brigham states the case for more hydro-electric power for all the mines. "Further annoying power shortage" during the year, "very materially affected the tonnage and costs"; hence the necessity for independent action by the Hollinger company. Not only that. The larger milling plan prompts Mr. Brigham to record this as a further definition of policy:

"As is well known, the veins in the Porcupine district do not have sharply defined walls, and the ore often extends into the country rock with gradually decreasing values. To mill the lowest grade of ore it will be necessary to work the whole plant on a larger scale, for the reason that if this low grade portion of ore from the walls of the stopes is ever to be mined, it must be taken while the operations are in progress."

The net profits for 1922 were $6,478,604.12, compared with $5,091,659.62 in 1921. Appropriation of profits was made as follows:

Dominion, provincial and municipal taxes	$518,223.67
Depreciation	813,690.18
Thirteen dividends of one per cent	3,198,000.00
	$4,529,913.85

A balance of $1,948,690.27 was added to surplus, which stood at $5,909,469.77 on Jan. 1. Net current assets are given in the balance sheet as $6,331,220.56, of which nearly $3,500,000 is in Dominion Victory Bonds.

In his report on behalf of the directors, Noah A. Timmins, president of the company, said that he expected per-

mission for the company to provide its own hydro-electric power. Until this matter was definitely settled, the board had deferred any increase in the dividends. Mr. Timmins signified the readiness of the board to do something more for the shareholders "when the power situation has been cleared and the very large financial obligations are provided for."

Mining Interests Oppose Two Bills Introduced in Arizona Legislature

One Proposes Tax of 1c. per lb. on Copper; Other Would Establish Literacy Test for Employees

The sixth Legislature of Arizona has now added another to the list of "radical" measures that have been introduced during the present session and which are directed at the mining corporations operating in the state. These bills, if allowed to become law, would be a serious burden to the industry, upon which over three-fourths of the state's population are dependent for a livelihood. The latest one, introduced by Senator Gilbert, of Maricopa County, levys a tax of 1c. per pound on all copper produced within the state. The bill provides that all producers shall be required to report the year's production to the assessor of the county in which the mining has been done, and fixes penalties for failure to comply. In introducing the measure, the Senator asserted that this was Maricopa County's reply to the amendment that had been attached to the Colorado River compact, inferring that if there was to be a tax of $5 per horsepower-year on all hydro-electric power produced in the state, then the proposed tax on copper is justified.

A bill introduced by Senator Kinney, of Gila County, would prohibit the employment of Mexicans and other foreigners who were not versed in the use of the English language. Such legislation was originally brought before the Legislature several years ago by Senator Kinney. The much-used argument that the employment of non-English speaking people is the cause of many accidents is advanced in support of the bill. The mining operators of the state feel that such a law, would curtail operations, which are, of necessity, largely dependent upon a supply of Mexican laborers. This is especially so since the cessation of work during 1921, when many of the white employees left the industry.

The "company store" bill, prohibiting the operation of a store by mining companies and the deduction from the employees wages for payment of merchandise purchased, has been defeated.

The Legislature is overwhelmingly democratic, and, because of the known "labor" tendencies of the Governor and most of his appointees, some burdensome legislation directed at the mining industry had been expected, but to date such measures as have been proposed have been defeated. It is believed that the Gilbert and Kinney bills will not pass.

Chino Copper Raises $750,000 by Sale of Treasury Stock

The acquisition of further interest in the Gallup American Coal Co., owned jointly by the Chino, Ray Consolidated, and A. S. & R. companies, has been effected with the proceeds of a sale of 30,000 shares of treasury stock at $25 by the Chino Copper Co., operating at Santa Rita, N. M. The Gallup mine is a bituminous property near the copper mines. This purchase assures Chino an adequate and steady supply of fuel; it rounds out the one department that has been the weak link in the chain. Chino is now a self-sustained unit.

In connection with this financing it is disclosed that Chino's reserves on Dec. 31, 1922, amounted to 103,965,894 tons of ore, an average grade of 1.52 per cent copper. If the company should treat every year 3,500,000 tons of ore, the life of the mine is estimated to be about thirty years, not allowing for any extension of known orebodies or the discovery of new ones.

From an original capacity of 1,000 tons of ore daily, Chino's milling plant has grown to a point where it can comfortably handle 11,000 tons ore per day. Employed in all departments are about 1,350 workmen.

Production and sales for the last five years follow:

	Production, Pounds	Cost, Cents	Sold, Pounds	Sale Price, Cents
1922	28,406,314	12.10	22,868,451	13.60
1921	9,137,282	15.07	35,213,067	13.08
1920	44,051,849	14.97	39,352,870	17.863
1919	40,488,706	15.53	38,136,260	18.324
1918	75,655,641	17.17	60,375,580	24.81

The company last year earned an operating profit of $664,986. After depreciation charges of $483,685 and a shutdown expense of $1,030,087, or total charges of $1,513,772, the year resulted in a net loss of $848,785. As of Dec. 31, 1922, current assets amounted to $4,500,027; current liabilities $2,040,254; working capital $2,459,773. The company does not include as a current liability a reserve for taxes and insurance amounting to $1,513,699. This would bring the final net working capital down to $946,074.

Newly Discovered Copper and Sulphur Deposits in Sweden Seem Important

Following an investigation of the recently discovered ore deposits in the Province of Vasterbotten, Sweden, the chief of the geological committee announces that the copper finds are of great importance, running at least 10 per cent copper of the country according to *Commerce Reports*. The largest deposit, he states, is from 575 to 650 ft. long and 30 to 50 ft. in thickness. From the shallow depth of only 15 ft. is estimated that the ore to be taken out will yield about 1,500 tons of copper. Pyritic ores have also been located, as well as ore containing zinc blende.

The deposits when opened may supply the requirements of the country without having to obtain sulphur from Norway and the United States. Official American records show exports from the United States to Sweden of 41,325 long tons of sulphur or brimstone in 1922. If it is possible to obtain from 100,000 to 150,000 tons of sulphur from these mines, imports will be unnecessary.

The richest ores have been found in the neighborhood of Bjurfors, but the fields extend from Skelleftea to Stensele.

Persistence of Premier Orebodies Encourages Neighboring Development

Good Ore Below No. 4 Tunnel—G. D. B. Turner Optimistic After Visit to British Columbian District

The definite proving of the extension of the orebody below the fourth level on the Premier mine, in the Portland Canal district of British Columbia, and the opening up of high-grade ore of the same character on the adjacent property of the B. C. Silver Mines, Ltd., have had an important effect. G. D. B. Turner, general manager of the Indian Mines, Ltd., says that the whole atmosphere in this section of the country has changed.

Confidence in the permanence of the camp has given place to doubt, and large prices are being asked for prospects which may become valuable but have not been proved. Eight properties have been working throughout the winter, Mr. Turner reports, and two or three will be shipping ore before the snow goes. The Indian has been under development without interruption, a considerable body of milling ore has been located, and the operators feel optimistic.

Only a few weeks ago Mr. Turner inspected the Premier, B. C. Silver, and Mobile, as well as the Indian mines. He was greatly impressed with the remarkable showing in the Premier, the largest silver producer in Canada. He is quoted as saying:

"For a time it was questionable how far the orebodies of the Premier would go below a certain horizon; it was feared that some values might give out below No. 4 tunnel. Not only are the orebodies continuing in the fissures . . . but new orebodies have been discovered. This, coupled with the new strike made on the B. C. Silver, has added great confidence. The Indian mine, lying further to the northwest, was perhaps the most actively worked mine during 1922, apart from the Premier. The Indian has employed seventeen men since last April. Though high-grade ore in quantity has not yet been found, good ore already has been disclosed."

New Silver-Lead Deposits in Tasmania

By Cable from Reuters to "Engineering and Mining Journal-Press"

Hobart, Feb. 26 — Promising discoveries of silver-lead lodes have been reported in the vicinity of Zeehan, near this city. A promoter's offer to float a company with a capital of £40,000 has been rejected by the discoverers.

United Verde Copper Costs 12.67c. per Pound, Says Smith

Reserves Total 11,000,000 Tons, Averaging 84 Lb. per Ton—Employees Will Be Taught Concerning Operations

The United Verde Copper Co. spends 12.67c. for each pound of copper produced, according to a statement made recently by H. De Witt Smith, general superintendent. This is distributed as follows: Labor, 3.67c.; fuel, 2.03c.; other supplies, 2.64c.; freight on bullion, 0.7c.; refining, 1.15c.; taxes, 1.98c.; and depreciation, 0.5c.

The company, operating at Jerome, Ariz., has begun a series of lectures to be given the employees with a view of better acquainting the men with the mine and the organization and to prepare them for positions of greater responsibility. These lectures are to be prepared and given by the heads of the various departments. The various lectures given will be printed in pamphlet form and copies will be distributed after the course is completed. The subjects to be given include a general description of the mines and detailed discussions of the occurrence of the ores, and the various steps of mining, from the breaking in the stopes, to marketing the finished product.

One of the first of these lectures was given by H. De Witt Smith. He discussed the early history of the property, enumerating the difficulties encountered, and led up to the description of the present efficiently operated mine. He disclosed the fact that, although the present production is 2,500 tons per day, developments are now planned with the definite purpose of maintaining an output of 3,000 tons per day. The steam-shovel operations are expected to produce 2,000 tons per day by 1924, at which time the new crushing plant will have been completed, allowing for an increase in the capacity of the smelter. The reserve of known and probable ore in the United Verde mine was given as 11,000,000 tons, with an average content of 84 lb. per ton, this tonnage including 5,000,000 tons in the steam-shovel and fire areas.

Anaconda Now Capitalized at $300,000,000

At a special meeting of the stockholders of the Anaconda Copper Mining Co. held at the company's office at Anaconda on Feb. 26, the proposed increase of the capital stock of the company from 3,000,000 to 6,000,000 shares of the par value of $50 each was authorized. More than 76 per cent of the stock was represented, and no opposition developed.

This action of the Anaconda Copper company completes the details incident to the purchase by the Anaconda company of 2,200,000 shares of the outstanding stock of the Chile Copper Co. and authorizes the company to complete the financial program announced at the time the Chile transaction was made public two months ago.

Utah Consolidated Loses Final Appeal in Utah-Apex Suit

The United States Supreme Court on Feb. 26 denied the petition for a writ of certiorari sought by the Utah Consolidated Mining Co. against the Utah-Apex Mining Co. to appeal a decision of the district court, sustained by the Third Circuit Court of Appeals, regarding title to orebodies in the West Mountain or Bingham mining district of Utah. The Utah Consolidated company, which owns the Highland Boy mine, claimed title by virtue of apex rights to copper and lead ore found within flat limestone beds which "outcropped" in its property. The orebodies in question underlay the claim of the Utah-Apex company. The latter company brought the suit to quiet the title and won in the lower courts, on the ground that the limestone bed was not a lode in the meaning of the statute; but that the ore was contained in nearly vertical veins that outcropped in the Apex ground. The effect of the Supreme Court's action is to permit the judgment of the lower courts to stand without review and therefore finally settles the case. Several million dollars' worth of ore was involved, and the case was bitterly fought.

Colorado Corporation Pushes Erection of Mill and Tram

Concentrator at Bonanza, and 7½ Mile Ropeway From Rawley Should Be Finished May 1.

The Colorado Corporation is rushing construction work on the mill and tramway, which will enable it to move daily to the smelter the product of 300 tons of ore daily from the Rawley mines in Saguache County, Colo. About $400,000 is being expended, the capital being furnished by the Davis interests in New York, former owners of the property, the American Smelting & Refining Co., and the Metals Exploration Co.

The Rawley ore is lead-silver-gold down to the 600 level, and gold-silver-copper from there down to 1,200 ft., the tunnel level. Many thousand tons of ore have been blocked out during development work to await improved methods of treatment.

Lewis Sanders is in charge of mine development and also of construction work, which is about two-thirds completed. The milling plant is of 300-ton capacity, and is arranged for expansion to 500 tons. Shipping ore and concentrates from the mine are to be conveyed over the hill to a loading station on the Denver & Rio Grande railroad by a 7½-mile rope tramway, which is nearing completion. It is expected that the mill will be ready for ore about May 1.

Gold Production in Victoria in 1922

By Cable from Reuters to "Engineering and Mining Journal-Press"

London, Feb. 17—The production of gold in Victoria, Australia, last year totaled 106,872 oz.

Increased Wages Probable in Michigan Copper Mines

Desired Increase in Output Can Be Effected in No Other Way, Many Believe—Spring Will Aggravate Shortage

The advance in the price of copper finds the Michigan mines short of men, and an increase of wages is being considered. The building-up process promises to be slow, as men of experience in underground work are not easily obtainable. The rising price of copper, however, will enable the mining companies to enter into competition for labor. At prevailing wage rates there appears to be little hope of making any appreciable gain in man-power.

Many of the men now employed in the mines work on farms in the summer, and with the approach of spring there will be a considerable exodus of this type of labor from the mines. This presents an additional problem. Not only must their places be filled, but many more must be attracted to the mines if normal production is to be reached.

The automotive centers continue to attract many men from the Lake district. It is the lure of high wages that appeals to them. A higher wage scale for underground work is apparently the only solution of the mines' labor problem in the opinion of men close to the situation. In the last three years, however, the copper-mining companies have not been in a position to pay more money to labor, and officials have been content to permit things to take their natural course. It is the prevailing opinion among them that the copper business is gradually being established on a more substantial, firmer basis. Accordingly, the companies, though they have had more or less trouble in maintaining underground organizations, have patiently awaited a favorable change in the situation.

Park City Mining & Smelting Co. Declares 12½c. Dividend

The Park City Mining & Smelting, which is a merger of the Judge Mining & Smelting, Daly West, and West Ontario properties, will on April 1 pay a dividend of $109,500, this being at the rate of 12½c. a share, or 2½c. in excess of the usual rate. This will bring the total amount paid from ground covered by the Judge and Daly West to $12,662,500. The West Ontario part of the holdings of the company recently acquired is new ground, held for many years unworked. It is traversed by a strong fissure system, which is entirely undeveloped. Production is at the rate of about 1,000 tons of ore a week, net smelter returns from which are $45 a ton. Most of the ore which is being shipped is coming from the new orebody opened during the last year on the 900 level. This has been opened for 1,400 ft. on its strike, and the deposit is approximately 25 ft. wide and 6 ft. thick. On Feb. 1 the company had cash and bonds on hand amounting to $694,000.

News from Washington

By PAUL WOOTON
Special Correspondent

Taxation and Artificial Restrictions Hamper South American Mining

Delegate to International Congress Sees Profit in Arsenic and Manganese Production—Iron-Ore Exploitation Handicapped by Lack of Fuel—Bolivian Tin Develops

MINING OPERATIONS in South America are handicapped by a system of taxation and certain other artificial restraints which militate against the expansion of the industry. Though there are exceptions where the foregoing statement would not apply, yet in the opinion of T. T. Read, of the U. S. Bureau of Mines, who just has returned from an extended trip through South America, where he attended the International Engineering Congress as a delegate for the American Institute of Mining and Metallurgical Engineers, this is one of the outstanding features of the existing situation in South America as it pertains to the mining industry.

Mr. Read made a study of ventilation at the St. John del Rey mine, at Villa Nova de Lima, in the State of Minas Geraes, in Brazil. The shaft on that property has reached a depth of 6,726 ft. and, therefore, is the deepest mine in the world. The rocks at that depth have a temperature of 120 deg. F. The temperature in the workings, however, has been reduced to 80 deg. by the introduction of refrigerated air. He was very much impressed with the effectiveness of this system, but he is convinced that it cannot be applied with the same practical results at the deep mines in this country, owing to the fact that the workings are too extensive to be cooled by this method. At the Brazilian mine the workings are not large and wherever possible they are refilled after the vein has been worked.

Both the St. John del Rey and the Ouro Preto, the two large gold mines in Brazil, are now producing arsenic. The arsenic recovery plant at the St. John del Rey has been in operation for several months, but that at the Ouro Preto began production during the time that Mr. Read was in Brazil. Mr. Read points out that that this arsenic is being made available just at a time when it will be particularly welcome in helping to overcome the world-wide shortage.

Brazil's great wealth in iron deposits cannot be developed to any great extent, because of the lack of fuel. An effort is being made to undertake the smelting of these ores in electric furnaces. Hydro-electric power is available in quantity at comparatively low cost, but Mr. Read points out that only a limited application of that type of smelting is economically possible in Brazil.

There is a brighter future in prospect for the manganese producers. The advantages of low mining costs, however, are offset to a considerable extent by the export tax and the charges levied against freight. The limiting factor in the production of manganese, however, is the car supply on the government railroad. In the present state of the federal treasury, it seems improbable that any additional equipment will be furnished in the near future.

Through prospecting for oil in Brazil has not been thorough, the areas thought to be most favorable to its occurrence thus far have proved disappointing. To date no oil has been found in commercial quantities.

In Chile income-tax legislation now is being formulated. There is some fear that this will add materially to the taxes of the mineral producers. Director Ganderillas, of the Chilean Geological Survey, however, has been active in pointing out the inadvisability of allowing this legislation to discourage the expansion of metal-mining in Chile, and it seems probable that his counsel will prevail. Chile does not seem to be at all nervous, Mr. Read says, over the prospects of competition from the fixation of atmospheric nitrogen. The general feeling there is that Chilean nitrate will be able to compete successfully with the manufactured product, although it is admitted that there may have to be some recession from present prices.

While in Bolivia, Mr. Read learned that the Caracolas tin mine, owned by the Guggenheim interests, is developing satisfactorily. The early operation under American ownership was somewhat disappointing, but further development has revealed occurrences of ore which are highly promising.

Electric shovels loading copper ore at Chuquicamata, Chile

Pittman Act Silver

Purchases of silver by the Bureau of the Mint during the week ended Feb. 24 amounted to 1,669,762 oz. This brings the total purchases under the Pittman Act to 159,796,674 oz.

Purchases of Arsenate and Nitrate by Government May Be Authorized

Measure Gets Support—Hope Is To Stimulate Production by Assuring Market

Priority of consideration for legislation authorizing an appropriation of $10,000,000 for the purchase of calcium arsenate and nitrate of soda by the Secretary of Agriculture for the use of farmers was voted by the Committee on Rules of the House of Representatives on Feb. 21. This action was taken on the insistence of practically every representative from the cotton growing states.

The argument which impressed the Rules Committee was that the Secretary of Agriculture could stabilize the arsenic situation by contracting at this time for large supplies of arsenic for future delivery. Despite the ruling high price of arsenic, the Rules Committee was told, producers hesitate to incur heavy expense looking to the bringing in of new production or to increase the percentage of recovery. Government specialists estimate that the average recovery of arsenic is 65 per cent. Refinements in the process, which will make possible a much higher percentage of recovery, can be introduced, but producers hesitate to incur the expense without some assurance as to the marketability of the product after the improvements have been completed. This, it was contended, can be overcome by the placing of contracts by

the Secretary of Agriculture, of sufficient size to justify the preliminary expenditures necessary to increase the output.

The action intended to expedite the legislation was taken in the face of statements made before the Committee on Agriculture by competent authorities that the present price for arsenic and the certainty of a continued shortage over a period of years would stimulate producers to leave nothing undone to augment their output.

Favorable Action on Gold-Silver Bill Anticipated Before Adjournment

Oddie and Rhodes Will Co-operate to Speed Consideration—Rhodes Outlines His Contentions

At the request of Senator Nicholson, who is ill, Senator Oddie has taken charge of the Nicholson bill proposing a Commission on Gold and Silver Inquiry. An effort to secure consideration of the measure out of order met with objection, but it should be reached in the regular order before the present session of Congress expires. At that time Senator Oddie will press for its passage. Once the measure has passed the Senate, it will have a privileged status in the House. Representative Rhodes, the chairman of the Committee on Mines and Mining, expects to call up the bill from the Speaker's table as soon as it reaches the House, which apparently will make possible the enactment of this legislation before the adjournment of Congress Saturday. Mr. Rhodes, in reporting the bill to the House and urging its passage, said his committee holds the following views:

"There are so many complex questions relating to the cost of production, reduction, refining, transportation, marketing, and uses of gold and silver that your committee is of the unanimous opinion a fact-finding commission should be created and report back to Congress the result of its inquiry as soon as practicable. This legislation has no bearing upon the questions of monometalism, bimetalism, or fiat money, nor does it propose a subsidy for either gold or silver.

"Yet with the governmental obligations of the world having increased from $43,000,000,000 to $300,000,000,000 since the beginning of the World War, it is apparent that the present metallic reserves for monetary purposes must be increased in order to relieve the strain upon world credit. This must be done, or the metallic money of the world will be debased, or a new monetary system established. England has recently reduced the amount of silver in her coinage from 925 to 500 fine, and many other countries are doing likewise. We believe an intensive study of the bearing this change is having upon the monetary affairs of the world, with many other basic changes in national and international affairs now going on, will prove helpful to the gold and silver industries of the United States."

He enumerated certain facts to emphasize the importance of the legislation. They are enumerated as follows:

"1. The annual production of gold and silver in the United States and in the world has been decreasing.

"2. Many of the silver mines will be compelled to close down and cease operation upon the expiration of the Pittman Act, unless something is done to improve the condition of the industry.

"3. Over 80 per cent of the silver of the world is produced in North America and the major portion of it is controlled by American citizens, yet the price of our silver is arbitrarily fixed by four London brokers, controlled by the Bank of England.

"4. Great Britain's control over the price and distribution of silver gives her an advantage in commerce in China and India, where the largest foreign silver market is found.

"5. Our export trade is adversely affected by conditions surrounding the production, marketing, sale, and use of silver.

"6. In 1919 $80,000,000 of gold went into jewelry and the fine arts in the United States, while our total production of gold for that year was but $58,000,000. The world's production of gold in 1915 was $474,000,000, and in 1922 it was but $327,000,000."

News by Mining Districts

By Special Correspondents in the Field

QUEENSLAND

Mount Morgan Main Factor in Gold and Copper Production—Plans for Mount Elliott Call for £520,000

Special Correspondence

Gold production of Queensland for 1922 was better than in 1921. This is entirely accounted for by the fact that the Mount Morgan mine was closed down for nine months in 1921, but was in operation for a like period of last year. As showing what an important factor this big concern is in the mineral output of Queensland, it may be mentioned that, though the increase in the gold yield in 1922 was about 40,000 oz., the production from Mount Morgan during the nine months it was in operation was 47,660 oz. The total copper production of this state last year was only 1,431 tons, Mount Morgan in nine months of that year contributed 1,339 tons of that production.

Satisfactory market conditions gave a filip to tin mining throughout the year. Good returns of this metal have come from the mines of the Kangaroo field, about 80 miles north of the port of Townsville, the chief producers of that center being the Sardine, Canary, and the Shrimp; and in the Herberton center, further north, a number of old mines that have been reopened are turning out well and several others are showing improvement as they are being developed. The year's mining has been marked by good prices for lead, but the output of this metal in Queensland has been almost entirely confined to that from the silver-lead ores treated at the Chillagoe state smelters, where the lead furnaces have been kept in blast, with the prospect of a working loss, solely to help the mining industry, and particularly to assist the working miner, in the Chillagoe and Etheridge districts.

The news that the directors of the Mount Elliott company have virtually made arrangements to obtain additional capital to the extent of £500,000, has an important bearing on the future of the Cloncurry district and of copper mining generally in Queensland. The mines and smelters of this company in the Cloncurry copper field have been closed down for nearly four years. For about eighteen months the directors have been endeavoring, first in the United States and for nearly the whole of last year in Great Britain and France, to raise the capital wanted to carry out the scheme formulated by W. H. Corbould, their consulting engineer and general representative, for the development of the company's group of Cloncurry mines and for the treatment, by a method of his own, of the low-grade ores from those mines. It now seems that the company is to be placed in a position financially to start that scheme. This involves the erection of central treatment works in the Cloncurry district and the construction of a railway, 80 miles long to connect the company's rich Mount Oxide mine, in the far northern part of the field, with the present Cloncurry railway system at Dobbyn, near Mount Cuthbert.

Mr. Corbould's recommended copper extraction process to treat the Mount Elliott ore is a leaching method, by which of course a heavy expense for fuel would be saved as compared with smelting—a saving which is a great desideratum in a region where coke costs from £5 to £6 per ton. The essential procedure of the process is a preliminary sulphating roast, followed by leaching and the chemical and electrolytic precipitation of metallic copper, producer gas being used for the whole metallurgical operation. Mr. Corbould has estimated the ore reserves of his company at 1,867,000 tons, with an average grade of 4.63 per cent. When he reported to his directors on this subject in 1920 he was convinced that, by the carrying out of his scheme, with copper at £80 per ton, the 3 per cent ores of the Mount Elliott group of mines could be made profitable; and he was satisfied that, with a working capital of £520,000, a profit of £2,000,000 could be made available from tonnages of ore which he knew to exist. This estimate of expenditure did not include the construction of the Mount Oxide railway, which is expected to cost £300,000, and which is considered an essential part of the scheme. The nominal capital of the Mount Elliott company, apart from the proposed increase, is £1,250,000.

Montreal Letter

Argonaut, Beware!—Dividends Out of Capital Sanctioned if Bill Passes

By ALEXANDER GRAY

It is reported that New York interests are in the open market for Argonaut shares. This company is operating at Pancake Lake, in eastern Ontario. Considerable development has been done to the 500 level, and a mill is being erected. Argonaut has been in the spotlight. It was offered in New York, has been extensively and extravagantly advertised, and all the $3,000,000 of capital has been placed with the public. Before or after the mill is completed the understanding is the company will be reorganized. There is enough money in the treasury to carry on until the mill starts. What will happen after that depends on the new territory to be acquired and the milling returns.

The claim is made that a grade of $15 will provide sufficient working capital. Undoubtedly there is a section containing profitable ore. Being faulted, however, the ground is not workable at low cost, and there is a lake to reckon with near a part of the upper workings.

A year or two ago New Yorkers to whom the proposition was submitted foresaw a reorganization. Since then everything in the treasury has been sold. Besides, under the terms of the transaction by which the property was taken over from the Huronia company, the latter is to have a substantial share of the net profits—after the Argonaut has been reimbursed for certain capital expenditures. Although the public was aggressively canvassed in this matter, nothing has been divulged as to the agreement with the vendor Huronia company. Consequently, purchasers of shares should be fully enlightened before investing.

Naturally, opinion is divided on the bill before the Dominion House of Commons, sanctioning the payment by mining companies of dividends out of capital. Its proponents claim that it had been referred to the law officers of the Crown, that "ample safeguards are provided," a "mining company seeking to pay dividends out of capital having to satisfy the authorities that it has ample assets to meet such liabilities." The special circumstances actuating the advocates of the measure have not been disclosed. Those who comprehend the incentive it would be, in a good many instances, to make such distributions, are apprehensive lest confusion worse confounded result. It is not the exceptional companies that are feared. The generalities have insufficient working capital. Moreover the determination of "assets," as set forth not infrequently, may lead to troubles already more than sufficient. However, the bill is on its way, and promoters are expectant.

The Agent General of British Columbia in London states that various mining enterprises are being planned over there, based upon Premier and Selukwe developments in the Portland Canal district. An amusing incident on the festive occasion upon which this announcement was made was the further statement that London is not entertaining anything in British Columbia before it consults the Agent General. Not often in the past or the present have such precautions been taken. Ever since the Leroy episode, which cost the Old Country a million sterling, interest in British Columbia has been cautious and spasmodic.

BRITISH COLUMBIA

Trail Ore Shipments

The Consolidated Mining & Smelting Co. received the following consignments of ore at the Trail Smelter during the period Feb. 8 to 14:

Name of Mine	Locality		Tons
Knob Hill	Republic,	Wash.	164
Lone Pine, Surprise, Last Chance	Republic,	Wash.	323
Nip & Tuck	Windermere,	B. C.	30
Paradise	Windermere,	B. C.	46
Quilp	Republic,	Wash.	55
Ruth	Sandon,	B. C.	40
Surprise	Republic,	Wash.	103
Silversmith, lead	Sandon,	B. C.	160
Silversmith, zinc	Sandon,	B. C.	77
Steel Group	Brisco,	B. C.	34
Standard	Silverton,	B. C.	81
Company mines			6,983
Total			8,096

ONTARIO

Power Company Plans 12,000 New Horsepower

The gold mines in the Porcupine district have experienced a second power cut within a week and are now receiving only about half of their normal requirements. This condition has occurred at low water during the last two or three years, but it is hoped that the plans which the Northern Canada Power Co. now has under way and in contemplation will prevent a recurrence. The power company purposes to construct, at an estimated cost of $1,000,000, another power plant at Kenogamissi, a few miles below the Wawiatin plant. The plan is to divert the waters of the Grassy River into Kenogamissi Lake, where it is estimated that from 3,000 to 5,000 hp. can be developed. In the meantime construction on the Sandy Falls plant is being rushed, and it is expected that the first unit will be in operation in March and the second unit a month or two later. This plant has an estimated capacity of 7,000 hp.

Record-breaking Cash Purchase; $1,130,000 Involved

The official announcement of the terms of the purchase of the Sylvanite property in the Kirkland district of northern Ontario by interests connected with the Wright-Hargreaves mine gives a higher purchase price than was first mentioned. The total amount involved is $1,130,000, of which $400,000 is to be placed in the treasury; the remainder, $730,000, going to the Kirkland Lake Proprietary in payment of the 891,000 shares of Sylvanite held by that company. This places the Wright-Hargreaves in possession of practically all of the three million shares of the Sylvanite. This is believed to be the largest cash consideration ever paid for a gold mine in northern Ontario.

CALIFORNIA

Engels Copper Company Earned $119,616 During 1922

San Francisco Correspondence

The Engels Copper Mining Co., operating in Plumas County, records a surplus of $20,505 for 1922. The value of the gross production was $2,116,055; copper produced 14,075,941 lb.; silver, 190,048 oz.; and gold, 2,074 oz. The gross earnings less freight and smelting charges were $1,419,810 and operating expenses $1,058,267; the development charge was $90,739; compensation liability $80,163; balance to profit and loss $190,640. A deficit from past operations amounting to $119,616, together with a depreciation of $50,518, was written off, leaving a surplus of $20,505. Two changes were made in the board of directors, Paul Messchaert and C. H. Bru were elected in place of Fred L. Berry and L. Hedemann. The present officers are F. Klamp, president; J. H. Humburg, vice-president; E. E. Paxton, treasurer, and general manager; C. H. Bru, assistant treasurer; and L. A. Bell, secretary.

Grass Valley Active—New Idaho-Maryland Vein Develops Well

The new vein recently discovered in the Idaho-Maryland mine has been opened up on one level. Development work is progressing on several other levels. The 20-stamp mill is operating on ore now in development. The Hilltop-Nevada Mining Co., which has operated a property south of Battle Mountain, Nev., has taken a bond on a group of mining claims in the Alta Hill section. Installation of a hoist and compressor for exploration purposes is to be made at once. Milling operations at the Alcalde have been successfully resumed. A crosscut is being driven on the 330 level of the Normandie-Dulmaine mine in the expectation of intersecting the Dulmaine vein, which yielded rich ore at the surface. Both the Deadman Flat section and the Canada hill district are attracting more or less attention.

Magnesite Mining Resumed

The present demand for magnesite has stimulated interest in this mineral. Apparently the market demand for magnesite is sufficient to more than absorb the available production. Work will be resumed on the Nichellini and Priest magnesite properties, in Chiles valley, near St. Helena.

Plymouth Consolidated Will Sink Winze to 4,000 Level

At the Plymouth Consolidated mine, at Plymouth, drifting south continues upon the 3,850 level, which is producing from development ore assaying $15 per ton. Cut samples taken in the south drift on this level average $20 per ton over a width of 8 ft. Preparations are being made to sink the winze to the 4,000 level. An intermediate level will be cut at 3,925 ft. The oreshoot appears to lie south of the winze, according to W. J. Loring, general manager.

NEVADA

Tonopah Divide Made $250,000 During 1922

During the month of January the Tonopah Divide mine, at Divide, produced 1,695 tons of ore, of an average value of $28.61 per ton, having a gross value of $48,494. February production will likely be less, as heavy snow interfered with motor-truck haulage to the Belmont mill, a distance of five miles, for a total of ten days. In addition, power service was interrupted for a day, during which time no mine work was possible. Profits for 1922 were approximately $250,000, or at the rate of over $20,000 per month. This is an excellent showing considering the small tonnage shipped, about 1,500 tons per month. The annual meeting of stockholders is to be held in Tonopah on March 7.

Tonopah Output at Maximum

The West End Consolidated, at Tonopah, is increasing its output 50 tons per day, the additional ore being shipped to the Tonopah Mining Co. mill at Millers, 14 miles from Tonopah. Daily tonnage mined is now 300 tons. The bulk of the ore is mined from the Ohio vein on the 500 and 800 levels. All Tonopah companies are running at maximum production in order to take advantage of dollar silver during the life of the Pittman Act.

Halifax daily production is to be raised from 25 to at least 50 tons, the ore coming from the stopes on the big vein between the 900 and 800 levels and above.

NEW MEXICO

Bonney and 85 Mines Ship Regularly

Ore shipments from the Lordsburg district for the month of January show an increase of 811 tons over the month previous. The shipments of siliceous copper ores for January amounted to 8,548 tons. The bulk of this ore was produced by the 85 Mine, and went to the C. & A. smelter at Douglas, Ariz. The Bonney mine is shipping the highest-grade ores ever sent out of this district. It shipped during January, 170 tons from the 325 level of No. 1 shaft that averaged 0.82 oz. gold, 7.56 oz. silver and 8.82 per cent copper.

Silver Ore in Last Chance and Co-operative Mines

The exploration work that the White Syndicate has been doing for the last three months, under the direction of J. R. Findleyson, at the Last Chance mine, south of Lordsburg, has met with success. A 7 ft. vein has been opened by a crosscut to the east, on the 375 level. Assays show 32 oz. in silver.

At the Co-operative property north of town a small force has been at work straightening up old workings. In doing this a new vein about 2 ft. wide that shows considerable native silver has been opened. A carload is being hauled for shipment to the El Paso smelter. Development work, based upon the new strike, has been started.

COLORADO

New Road Would Stimulate Mining

A strong effort is being made by the commissioners of Lake and Park counties to have the State Highway Commission designate as a state highway a stretch of road extending from Leadville up Big Evans Gulch to Mosquito Pass, thence down Mosquito Gulch to Alma, following the old stage trail. The project involves the building of about five miles of new road between the London mine, on one side, and the Resurrection mine, on the other side, of the range in Lake County.

Besides affording improved facilities for transporting Park County ores to the Leadville smelter, the road would shorten the distance by motor between Leadville and Denver to 106 miles. The distance at present is 166 miles. It is claimed that the road can be put in first-class condition for $50,000, and that it would be open for travel from June until November. The Highway Commission is petitioned to join with the counties in constructing the road.

No Burdensome Legislation Seems Likely to Pass

A drastic mine-taxation law proposed by the Colorado Tax Commission has been killed by the Colorado Legislature, now in session, as have been several "labor" measures that would materially increase the cost of mine operation. A bill to change the Industrial Compensation Law, increasing the weekly payment for injury from $10 to $17, and to cut down the waiting period from ten to seven days was amended and passed the House, fixing the weekly payment at $12 and the waiting period seven days. It will probably pass the Senate in this form, with possibly the waiting period restored to ten days.

The "blue-sky" measure, prepared by the Legislative Committee of the Colorado Metal Mining Association, has been favorably recommended in committee.

MONTANA

Butte & Superior Will Ship Copper Ore

The Butte & Superior Mining Co. is to begin immediately the hoisting of copper ore from its newly developed copper vein. A year ago in exploring for the downward extension of its zinc ore body, the company encountered on the 2,000-ft. level of the Black Rock mine a new orebody that assayed well in copper. Further exploratory work disclosed that on the 2,200 and 2,600 levels the new copper vein was fully as well defined and that the ore was as rich.

The company erected new ore bins on the surface so as to hoist its ore through the present shaft, and has been waiting for the copper market to improve.

In the meantime, the company has continued to develop the vein. Under its contract, Butte & Superior supplies about from 30,000 tons of zinc ore each month to Anaconda. On the rising zinc market of the past few months Butte & Superior profits have grown.

UTAH

Leaching "In Place" Continues Successful

Salt Lake mining men and others are watching with much interest the leaching in place operations of the Ohio Copper Company near Bingham, according to officials, which promise financial success when the process is placed on a commercial basis. Shipments of precipitate recovered during twenty days' operation in January with a launder capacity of 1,500 ft. assaying 89.22 per cent copper and produced at a cost of less than 8c. per lb., brought net smelter returns of $10,224. At present only 300 gal. of water per minute is being used, and although the same space has been leached for more than a month, the copper content of the effluent solution has been held at an amount best adapted to the limited launder capacity at present in use. The launder capacity which it is planned to install will total 4,400 ft.—2,200 ft. on each side of the Mascotte tunnel, which underlies the deposits. When this launder capacity has been attained, more water will be used, and the grade will be held higher. In a short time the company will be using 1,000 gal. of water per minute, and the unit cost of production should decrease materially.

Park-Utah Increases Shipments; 15c. Dividend

The Park-Utah, now one of the largest shippers in the Park City district, with a production of about 240 tons a day, is planning to increase production until an output of 300 tons daily has been reached. This remarkable new producer will on April 1 pay a regular quarterly dividend of 15c. a share, bringing the total distributed by the company, which began payments about two years ago, to $1,250,000. January earnings amounted to about $117,000, and on Feb. 1 the company had cash on hand amounting to $435,000. The average value of the ore shipped during the month was $35 per ton, and the grade will be higher from now on. The value of the ore is increasing with depth, and ore running from 50 to 168 oz. in silver has been found. The orebody has been developed from the 1,300 to the 1,500 level for a distance of 1,300 ft. on its strike. The 1,600 level is being opened.

Ore Shipments From Utah Camps

Bingham—Total, 110 cars. Shippers were: United States mines, 72 cars; Utah-Apex, 22; Bingham Mines, 10; Montana Bingham, 6.

Eureka—Total, 163 cars. Shippers were: Chief Consolidated, 66 cars; Tintic Standard, 55; Dragon, 9; Victoria, 8; Eagle & Blue Bell, 7; Colorado, 5; Iron Blossom, 6; Iron King, 2; Mammoth, 2; Eureka Hill, 1; American Star, 1; Centennial-Eureka, 1.

Park City—Total, 5,026 tons. Shippers were: Park-Utah, 1,676 tons; Silver King Coalition, 1,516; Park City Mining & Smelting, 1,222; Ontario, 432; Keystone, 180.

OREGON

Copper Trust Syndicate Finds Copper-Silver Ore

Recent reports from the Homestead district on the Snake River in Oregon and Idaho, to the effect that the Red Ledge and Iron Dyke properties will be operated on a large scale have stimulated mining activities in the district.

The latest development is a strike made by the Copper Trust Syndicate, which own thirteen claims and two fractions joining the Iron Dyke mine on the south. This company has been quietly operating in the district for the last two years during which it has done about 2,000 ft. of underground development, which has opened up two veins on the property. In a drift on the 100 level of the main working shaft a vein 11 ft. wide carrying 7 per cent copper and 18 oz. silver was opened a few days ago. The ore is similar in character to that of the Iron Dyke mine, a susbtantial copper producer. The ore will be developed as rapidly as possible.

IDAHO

Molybdenum Prospect Being Developed

The International Molybdenum Co. under the direction of Martha J. Hinton, is developing promising property near Porthill, Idaho. Passing through the Northern Chief claim is a pegmatite dike, in diorite. The dike is 200 ft. wide. The other claim, known as the Hotentott, contains a fissure vein, lying practically at right angles with the pegmatite dike. An analysis of the ore taken at a depth of 6 or 7 ft. on this vein shows 5 per cent molybdenum.

The No. 1 tunnel when driven about 75 ft. will cut the vein at a depth of 55 ft. No. 2 tunnel, now being driven, and in approximately 60 ft., follows the dike. Analysis of all ore at the portal of this tunnel shows 1.81 per cent, or 38 lb. of molybdenum to the ton. This tunnel is all in ore as far as it has been driven. Plenty of water can be had on the claims for milling purposes; and approximately 300 hp. of hydro-electric energy can be developed.

There is plenty of timber in the vicinity for mining purposes. There are good cabins on the ground, and the camp is equipped and supplied to operate until April.

WASHINGTON

Tax and "Blue-Sky" Measures Proposed

The State Legislature now in session is struggling with several new bills which if passed will seriously effect mining operations in the state. One bill introduced in the Senate provides for incorporation fees for a million-dollar company of $750, with an additional license fee of $250, with proportionate increases for larger corporations. A second bill provides for the repeal of the Richardson Tax Act, which taxes a mining company on its surface improvements and $5 per acre on the land covered by its location; and in addition thereto taxes net production. It is supposed to substitute for this law an act giving the assessors arbitrary powers to determine valuations on speculative possibilities which cannot be determined accurately by engineers of highest qualifications.

The third measure before the legislature is a drastic "Blue-Sky" Law sponsored by the Investment Bankers of Seattle, containing provisions delagating authority to the Secretary of State to pass upon the good faith and standing of mining projects.

ARIZONA

Ray-Hercules Repairs Plant

About sixty men are now employed at the Ray-Hercules mine, at Ray. Although some development is being done, most of the men are engaged in repairing and getting the plant ready for a resumption of mining and development, if, and when the orders are given. Work has been delayed somewhat owing to the slowness of timber delivery.

Boras Lease Works Seventy Men

The Boras Leasing Co. is now shipping 2,000 tons per month from Bisbee to the Copper Queen smelter, at Douglas. This ore averages about 7 per cent copper and is being mined between the 700 and 400 levels. This company is also driving drifts on the 900 and 1,100 levels into the Tuscarora claim, which adjoins the Sunnyside claim, owned by the Calumet & Arizona Mining Co., in which an orebody has been followed to the end line. Sixty or seventy men are employed at the Boras.

Production Will Be Increased by Irish Mag

The Irish Mag Leasing Co., which is working the Irish Mag property of the Calumet & Arizona Mining Co., at Bisbee, shipped sixteen cars of ore to the smelter last month that contained between 5 and 6 per cent copper. This ore was mined between the 950 and 1,050 levels. It is planned to increase production.

WISCONSIN

New Iron Ore Docks

The Great Northern Railroad Co. will rebuild its No. 1 ore dock on Allouez Bay at Superior. Owing to the length of time that that will require and the desire not to interrupt the handling of ore during shipping seasons, the plans call for the construction of the first 188 pockets between the shipping seasons of 1923 and 1924 and the remaining pockets between the seasons of 1924 and 1925.

This dock is of timber and was built in 1907. It has 374 pockets of 300 tons each, and is 73 ft. high. In the reconstruction of the pockets the height will be raised to 77 ft., which will give additional capacity. The new No. 2 ore dock of the same company, which is constructed of reinforced concrete and steel, is rapidly nearing completion. This dock is 2,100 ft. long, with 350 pockets of 5,175 cu.ft. capacity each, or approximately a total storage capacity of 122,500 tons.

JOPLIN-MIAMI DISTRICT

"Cones" Largely Used in New Gordon Concentrating Plant

The Gordon Mining Co. is planning to have one of the largest mills in the field when it completes the moving of the old Producers-Hopkins mill to the Gordon lease, at Picher. Seven shafts are already down on the Gordon company's 200 acres of leases, and to take care of the "dirt" that can be hoisted, the company is enlarging the mill, while it is being rebuilt. Ultimately it will be able to handle at least 1,000 tons per day. Approximately eighteen "cones" will be used in the reconstructed mill, indicating the manner in which this district is taking to the cone in concentration work. A. C. Moses, of Joplin, is in charge of the Gordon company.

Lead Ore Developed on Hunter Land

A 150-ton concentrator is being erected on a lease of the Hunter land, south of Baxter Springs, Kan., by a company composed of Joplin men, James Warren, of Joplin, being manager. Part of a mill recently purchased by them and located northwest of Joplin will be used in the construction of the new plant. Preliminary development work of the ground at the property has developed considerable lead ore.

MINNESOTA

New Scheme for Open-Pit Drainage

The Oliver Iron Mining Co. has started work at its mines in the Virginia district incidental to the handling of the ore from the Missabe Mountain pit and also the stripping of the Minnewas property. At present a crushing and screening plant is being erected which will serve both properties, and track arrangement is now being made whereby ore from these properties can also be taken to the Leonidas concentrator at Eveleth. The stripping of the Minnewas open pit will involve the removal of approximately 8,000,000 cu.yd., which will uncover 11,000,000 tons of ore. A small tonnage has previously been shipped from this property from underground workings, but this tonnage was mined from the area beyond the stripping limits.

A novel experiment is being tried for the drainage of the Missabe Mountain pit. The present method of drainage for open pits is to sink a drainage shaft and to drive drainage drifts under the deposit. The experiment that is being tried consists of sinking a pit through the surface to the top of ore and then drilling 18-in. drainage holes below the steam-shovel datum elevation. It is assumed that all the water will drain to these holes, from which it will be removed with a deep well pump. The location of these drainage holes has been selected in reference to the dip of the various stratifications. The experiment if successful will prove more economical, and is being watched with great interest on the Mesabi Range.

THE MARKET REPORT

Daily Prices of Metals

Feb..	Copper, N. Y. net refinery*	Tin		Lead		Zinc
	Electrolytic	99 Per Cent	Straits	N. Y.	St. L.	St. L.
22	.....	.....	.....	....	.....	.....
23	16.00@16.25	43.375	44.625	8.10	8.10@8.15	7.30@7.40
24	16.25	43.375	44.625	8.10	8.15@8.20	7.3 @7.45
26	16.375	42.875	44.25	8.125	8.15@8.25	7.50@7.55
27	16.375@16.50	43.25	44.875	8.15	8.20	7.55@7.65
28	16.50	45.50	46.75	8.15	8.20	7.60@7.70

*These prices correspond to the following quotations for copper delivered: Feb. 23d, 16.25@16.50c.; 24th, 16.50c.; 26th, 16.625c.; 27th, 16.625@16.75c.; 28th, 16.75c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Tin quotations are for prompt deliveries. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

The quotations are arrived at by a committee consisting of the market editors of *Engineering and Mining Journal-Press* and a special representative of the Bureau of Mines and the Bureau of Foreign and Domestic Commerce.

London

Feb.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
22	69⅞	70⅝	76½	197¾	199⅛	29¼	28¾	35⅞	36
23	71	71¾	77½	200½	202¼	29⅜	28⅞	36⅛	36⅜
26	71¾	72⅜	79	199½	201½	29⅜	28¾	36½	36½
27	72	72¾	79½	201	202¾	29⅜	28¾	37	37
28	72⅜	73	79½	209¼	210¼	29¼	28⅝	37⅛	37⅛

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver and Sterling Exchange

Feb.	Sterling Exchange "Checks"	Silver			Feb.	Sterling Exchange "Checks"	Silver		
		New York Domestic Origin	New York Foreign Origin	London			New York Domestic Origin	New York Foreign Origin	London
22	.....	...	...	31	26	4.69½	99⅜	65⅜	31⅜
23	4.71⅝	99⅝	64⅞	31	27	4.71	99⅝	66	31⅝
24	4.70¾	99⅝	64⅞	31	28	4.70¼	99⅜	66⅜	31¾

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-quarter of a cent premium.

Average Metal Prices for February

Copper:	
New York Electrolytic	15.355
London Standard	67.700
London Electrolytic	74.500
Lead:	
New York	8.050
St. Louis	8.093
London	28.519
Silver:	
New York, foreign	64.313
New York, domestic	99.625
London	30.875
Sterling Exchange	468.631
Zinc:	
St. Louis	7.152
London	35.613
Tin:	
99 per cent	40.693
Straits	42.011
London	190.513
Antimony	7.290
Quicksilver	70.636
Platinum	113.273

Metal Markets

New York, Feb. 28, 1923

Copper

The daily advance in copper prices has continued until now 16.75c. delivered has been reached, this figure being generally quoted by all producers today. Some copper was also sold at that price yesterday, though early in the day two or three producers had not yet come up to that level. Sales have not been quite so great as last week, but this has been more because producers have been inclined to discourage reckless buying rather than any lack of inquiry. A particularly encouraging feature of the week has been a good export demand, which has made some producers care little about booking further domestic orders. Some of the export business has been for the Orient.

Lead

The official contract price of the American Smelting & Refining Co. was advanced on Friday, Feb. 23, from 8 to 8.10c., New York.

The market is somewhat firmer though no unusual activity has marked the week and lead is available for almost any delivery in any reasonable quantity. The importation of virtually the entire Mexican product has served to take care of even the large current needs of domestic consumers. A few lots of lead have been sold at premium prices, one lot for forward delivery bringing as high as 8.35c., but most of the business has been placed on the books at 8.10c.

The St. Louis market continues slightly above that at New York, with sales reported as high as 8.25c. Yesterday, however, a good-sized tonnage for any delivery was offered at 8.20c. without finding a taker.

Zinc

Sales of zinc have been brisk and of large volume. Domestic consumers who stayed out of the market when prices were lower than they are now came into the market with a rush so that quotations advanced daily. Export business has been neglible during the last week, the demand from American manufacturers accounting for the activity and heavy sales. Today zinc can be obtained for 7.60c. for May, June, and July shipment, whereas spot metal commands 7.65@7.70c. Zinc is edging closer to the price of lead. The price of high-grade metal has been advanced to 8.50c., with 30c. per 100 lb. freight allowance from Eastern shipping points. Business is also excellent in the purer grades.

New York quotations for Prime Western continue 35c. per 100 lb. above St. Louis quotations.

Tin

The London market has again registered a rapid advance, which, with the strength in sterling, has brought the New York price up close to 47c. Tin for forward delivery has commanded premiums of one-eighth to one-quarter cent. Deliveries of tin for February were around 6,200 tons.

Arrivals of tin, in long tons: Total to Feb. 23 inc., 4,885.

Gold

Gold in London: Feb. 22d, 87s. 6d.; 23d, 87s. 6d.; 26th, 87s. 9d.; 27th, 88s. 1d.; 28th, 88s.

Foreign Exchange

On Tuesday, Feb. 27, cable quotations on francs were 6.1375c.; lire, 4.8325c.; marks, 0.00445c.; and Canadian dollars, 1.75 per cent discount.

Silver

Continued buying by the Indian bazaars and by China advanced prices, so that both the London and New York markets closed at the highest quotations for the month.

India's position is favorable, with a daily offtake of 250 to 300 bars, according to latest advices from Bombay. China's position, on the other hand, is uncertain, although buying orders from that quarter have predominated lately.

Mexican Dollars—Feb. 23d, 49½; 24th, 49½; 26th, 49⅝; 27th, 50⅛; 28th, 50⅛.

Other Metals

Quotations cover large wholesale lots, f.o.b. New York, unless otherwise specified.

Aluminum—General market for 99 per cent grade, 24c. per lb.; 98 per cent, 23@23.5c. London quotations, £90@£100.

Antimony — Chinese and Japanese brands, 7⅞c. W. C. C., 8c. Cookson's "C" grade, spot, 8⅜@8¾c. Chinese needle antimony, lump, nominal, 5½@5½c. per lb. Standard powdered needle antimony (200 mesh), at 5½@6c. per lb. White antimony oxide, Chinese, guaranteed 99 per cent Sb_2O_3, 6⅞@7⅛c.

Bismuth—$2.55 per lb. London, 10s.

Cadmium—$1.15 per lb. London quotes 5s. 6d.

Cobalt—Metal, $2.65@$2.85 per lb.; black oxide, $2 per lb. in bbls. London 11 to 12s. for metal; black oxide, 9s.

Iridium—$260@$275 per oz.

Magnesium—Sticks, 1⅛ in., 99.9 per cent, $1.25 per lb. London quotes 4s.@4s. 9d. for 99 per cent.

Molybdenum Metal—In rod or wire form, 99.9 per cent pure, $32@$40 per lb., according to gage. Metal powder, 96@98 per cent, $3.50@$4 per lb.

Monel Metal — Shot, 32c.; blocks, 32c. per lb., f.o.b. Bayonne, N. J.

Nickel—25@30c. per lb. for 99 per cent virgin metal.

Osmium—Pure, $80@$85 per oz. troy, in Los Angeles. Strong.

Palladium—$79 per oz. London, sponge, £11@£12 10s.

Platinum—$110 per oz. London, £23.

Quicksilver—$70 per 75-lb. flask. San Francisco wires $68. London, £12.

Radium—$70 per milligram of radium content.

[1]**Rhodium**—$4.50@$5 per gram.

Selenium — Black powdered, amorphous, 99.5 per cent pure, $2.15 per lb.

[1]**Tellurium**—$3 per lb. in 10-lb. lots.

[1]**Thallium Metal**—Ingot, 99 per cent pure, $4 per lb. in 25-lb. lots.

Tungsten Metal—Powder, 97 to 98 per cent, $1 per lb. contained tungsten.

Metallic Ores

Chrome Ore—Indian chrome ore at $20 per ton, c.i.f. Atlantic ports. Rhodesian and New Caledonian, $24.

Iron Ore—Lake Superior ores, per long ton, Lower Lake ports: Old Range bessemer, 55 per cent iron, $5.95; Mesabi bessemer, 55 per cent iron, $5.70; Old Range non-bessemer, 51½ per cent iron, $5.20; Mesabi non-bessemer, 51½ per cent iron, $5.05.

Magnetite Ore—F.o.b. Port Henry, N. Y.: Old bed 21 furnace, $5 per long ton; old bed concentrates, 63 per cent, $5.25; Harmony, cobbed, 63 per cent, $5.25; new bed low phosphorus, 65 per cent, $7.50.

Manganese Ore—33c. per long ton unit, seaport, plus duty; Chemical ore, $75@$80 per gross ton.

Molybdenum Ore—65c. per lb. of MoS_2 for 85 per cent MoS_2 concentrates, plus duty.

Tantalum Ore—Hand-sorted ore, 70 per cent combined columbite-tantalite, 40c. per lb., South Dakota.

[1]**Titanium Ores**—Ilmenite, 52 per cent TiO_2, 1½@2c. per lb. for ore. Rutile, 96 per cent TiO_2, 10c. per lb. for ore, with concessions on large lots or contracts.

Tungsten Ore — Wolframite, $8; scheelite, $8.50@$9 per unit of WO_3.

Uranium Ore (Carnotite)—Ore containing from 2 to 2½ per cent U_3O_8, $3.50 per lb. of contained U_3O_8.

Vanadium Ore—No quotation. Recently $1 per lb. of V_2O_5 content.

Zircon — Zirconium silicate, f.o.b. Pablo, Fla., 4½@13c. per lb.

Zinc and Lead Ore Markets

Joplin, Mo., Feb. 24—Zinc blende, per ton, high, $48.20; basis 60 per cent zinc, premium, $46@$47; Prime Western, $45@$46; fines and slimes, $45@$42; average settling price, all blende, $44.17. Calamine, basis 40 per cent zinc, $26@$28; average, $27.22 per ton.

Lead, high, $115.40; basis 80 per cent lead, $110@$115; average settling price, all lead ore, $108.62 per ton.

Shipments for the week: Blende, 17,478; calamine, 101; lead, 1,966 tons. Value, all ores the week, $982,820.

Shipments for two months: Blende, 100,557; calamine, 961; lead, 13,929 tons. Value, all ores two months, $5,644,300.

Heavy loading of ore from Kansas was the notable feature of the month. On March 1, tax assessments are levied in that state, and holders have disposed of considerable reserve stocks of blende.

Platteville, Wis., Feb. 24—Blende basis 60 per cent zinc, $48 per ton. Lead, basis 80 per cent lead, $112 per ton. Shipments for the week: Blende, 868 tons; lead, 65 tons. Shipments for the year: Blende, 5,909; lead, 145 tons. Shipments for the week to separating plants: 572 tons blende.

[1]Price furnished by Foote Mineral Co., Philadelphia, Pa.

Non-Metallic Minerals

Asbestos—Crude No. 1, $450@$550; No. 2, $250@$350; long spinning fibers, $150@$250; magnesia and compressed sheet fiber, $125@$175; shingle stock, $60@$80; paper stock, $30@$40; cement stock, $15@$20; shorts, $8@$12—all per short ton, f.o.b. mines, Quebec, Canada.

Rhodesian No. 1 crude, $400; No. 2, $250; inferior grade, $200—all c.i.f. Atlantic ports per short ton.

Barytes—Crude, $9 per ton; white, dry ground, $16@$17; white, wet ground, $22@$25 per ton; off color, dry ground, $13@$14; off color, wet ground, $15@$16 f.o.b. plant.

Bauxite—American, crushed and dried, $6@$9 per gross ton; pulverized and dried, $12@$14 per gross ton; calcined, $22@$25 per gross ton, all f.o.b. shipping points. Foreign bauxite offered at $5@$8 per metric ton, c.i.f. Atlantic ports, depending upon grade.

Borax—Granulated and refined, crystals or powdered, in bags, carloads, 5¼c. per lb.; in bbls., 5½c. Boric acid, 11c.

Chalk—English, extra light, 5c. Domestic light, 4½@4¾c.; heavy, 3½@3⅝c. per lb., all f.o.b. New York.

China Clay (Kaolin)—Crude, $7@$9; washed, $8@$9; powdered, $13@$20; bags extra, per net ton, f.o.b. mines, Georgia; powdered clay, $14@$20, f.o.b. Virginia points. Imported lump, $15@$22 f.o.b. American ports; powdered, $45@$50, f.o.b., New York. 1A grade, refined, $15 per ton, Delaware.

Canadian, in lumps, $16@$18, f.o.b. Quebec points. Demand good.

Diatomaceous Earth — Crude, air-dried material, in large lumps, $8 per ton, f.o.b. California quarries. Ground material for insulation is priced according to density. It is being sold for $35 per ton, having a settled weight of 15 lb. per cu.ft., and $25 per ton for 20 lb. per cu.ft. The highest grade of material, the so-called "air float" or "bag-house," suitable for polishes and similar uses, brings from $75 to $100 a ton. All prices f.o.b. quarry. Contracts with large consumers are at present in force at a figure as low as $17 per ton, f.o.b. quarries, for filter material. All above quotations are on a minimum car basis, a minimum car holding 20 tons of 2,000 lb.

Emery — Turkish and Greek manufactured emery, 6@8c. per lb. American, 3½@5½c. Inferior grades, 3½c., f.o.b. New England points. Imported Turkish and Naxos emery scarce and hard to secure because of conditions in Turkey and Greece.

Feldspar — No. 1 pottery grade, $6@$7.50 per long ton; No. 2, $5@$5.50; f.o.b. North Carolina points. No. 1, $7.50; No. 2, $6.50; ground, 60 to 80 mesh, $18@$20 per short ton; 120 to 150 mesh, $20@$24; 200 mesh, $25@$30, f.o.b. Connecticut points. No. 1, Canadian, 120 mesh, $20 per net ton, f.o.b. Ohio mills.

First quality ground, $19 in New

Hampshire, $18 in Maine; second quality, $16 in New Hampshire. In Colorado, No. 1 crude, $5; No. 2, $4.50 per short ton.

Fluorspar — Fluxing gravel, 85 per cent CaF_2 and not over 5 per cent silica, $21.50, f.o.b. mines; not over 6 per cent silica, $21; 80 per cent grade, not over 5 per cent silica, $20; ground acid grade, $45 in bulk; ground enameling grade, $35 in bulk; packages, $4 extra, all f.o.b. mines, Illinois.

Gravel with limestone gangue, $14; lump, 92 per cent CaF_2, $17, f.o.b. New Mexico.

No. 1 lump, $30; No. 2, lump, $25, f.o.b. Illinois mines.

Fuller's Earth—16 to 60 mesh, $19 per ton; 16 to 30 mesh, $17; 30 to 60 mesh, $18; 60 to 100 mesh, $14; 100 mesh and finer, $10; f.o.b. Florida mines.

Graphite—American flake, 4@5c. per lb. at mines. Ceylon lump, first quality, 6@6½c. per lb; chip, 5@5½c.; dust, 3½@4c. Mexican crude amorphous, $15@$35, f.o.b. New York. Flake graphite, 15@30c. per lb.; foundry grades, 4@6c.; boiler, 8@14c.; lubricating, 10@50c. per lb.

Gypsum—Crushed rock, $3 per ton in most states. Ground, $3.50@$4, f.o.b. shipping points.

Kaolin—See China Clay.

Limestone—Crushed, New York State shipping points, ¾ in. and larger, $1.10 @$1.35 per net ton. Agricultural limestone, $2.50@$3 net ton, f.o.b. eastern shipping points.

Magnesite—$14 per ton for crude, $40 for calcined magnesite, f.o.b. California points. Dead-burned magnesite grains, $40 per net ton, f.o.b. Baltimore; $40@$42, Chester, Pa.

Western magnesite industry reports increased activity. Plastic material finding good use.

Manjak—Barbados, in 1 to 5 ton lots, grade "C" lump, $330 per short ton; "C" fine, $250; grade "A," $185—all c.i.f. New York.

Mica—Domestic, No. 1 quality, 1¼x2 in., 15c. per lb.; 2x2 in., 35c.; 2x3 in., 80c.; 3x3 in., $1.20; 3x4 in., $1.60; 3x5 in., $2; 4x6 in., $2.80; 6x6 in., $3.60, all per lb., f.o.b. North Carolina, thumb trimmed; 1¼ in. disks, 75c. per lb. No. 2 stove mica: punch, 8c.; 2x2 in., 25c.; 2x3 in., 50c.; 3x3 in., $1; 3x4 in., $1.40; 3x5 in., $1.75; 4x6 in., $2.25; 6x8 in., $3.25; flake, 12c. per lb. Scrap, $25 per ton. All f.o.b. Virginia points.

Scrap, $22 per short ton; washer, 10c. per lb.; disk, 15c. per lb., f.o.b. Connecticut points. Market active.

[1]**Monazite**—Minimum 6 per cent ThO_2, 6@8c. per lb.

Phosphate — 77 to 76 per cent tricalcium phosphate, hard rock, $7.25 per ton, f.o.b. Jacksonville; 77 to 76 per cent pebble grades, $6.75; 75 to 74 per cent pebble, $5.50; 70 per cent pebble, $4.35; 66 to 68 per cent pebble, $3.90, f.o.b. Tampa.

For 78 per cent lump, kiln dried, $8; 75 per cent, $6.50@$6.75; 72 per cent washed and cylinder dried, unground, $6@$6.50 per long ton; 70 per cent ground, $6.50 short ton; 65@70 per cent ground, $6 per short ton, f.o.b. Tennessee points.

Pumice Stone—Imported lump, 3@40c. per lb.; domestic lump, 5c.; ground, 5@6c., all f.o.b. New York.

Pyrites—Imported lump, 1 in. diameter and up, 12c. per unit; furnace size, 2½ in. diameter, 12½c. per unit; fines, through ½-in. mesh, 12c. per unit; cinder property of buyer, ex ship, Atlantic ports. Ore contains 50@51 per cent sulphur; cinder about 63 per cent iron.

Silica—Glass sand, generally $2@$2.75 per ton, f.o.b. shipping point; sand-blast material, $2.50@$5. Ground, 250 to 450 mesh, $22@$34, f.o.b. mills. Glass sand, $5@$10, f.o.b. Mass.

Sulphur—$16@$18 per ton for domestic, f.o.b. Texas and Louisiana mines; $18@$20 for export, f.a.s. New York.

Talc—150 to 200 mesh, $6.50@$8.50 per ton, Vermont. Price depends upon color as well as fineness. Paper bags, $1 per ton extra. Burlap bags, 12 to the ton, 10c. each extra, with 9c. return allowance.

In New York, 200 to 325 mesh, $13.75 @$14.75 per ton for air-floated talc. 300 mesh, $11.50@$14.75 per ton.

In Georgia, white, $7@$9; yellow, $9; red, $11.

In California, $16@$20 per ton, depending upon fineness and color.

Tripoli—Once ground, rose and cream colored, $16@$25; white, $18@$27; double ground, r. and c., $17@$25; w., $19@$30; air-float, r. and c., $25@$30; w., $35; super air-float, r. and c., $35@$40; w., $40@$45. All per short ton in 200-lb. burlap bags with paper liners, minimum car, 30 tons, f.o.b. Mo.

Mineral Products

Arsenious Oxide (white arsenic)—14@15c. per lb.

As a result of recent Senate action, an initial Governmental Conference on the white arsenic situation, was held in Washington, Feb. 17, Dr. G. F. Loughlin, U. S. G. S., H. S. Mulliken, Bureau of Mines, and Dr. B. R. Coad, Dept. of Agriculture, with associates, represented their respective departments. The meeting discussed the existing demand for arsenic, for use in insecticide manufacture.

Copper Sulphate — Large crystals, 6.50c. per lb.; small, 6.40c.

Sodium Nitrate—$2.475 per 100 lb., ex vessel Atlantic ports.

Potassium Sulphate — Powder, domestic, $1 per unit, basis 90 per cent.

Sodium Sulphate—$25@$27 per ton, New York.

Ferro-Alloys

Ferrocerium—Per lb., $15@$20.

Ferrochrome—1 to 2 per cent carbon, 28c. per lb.; 4 to 6 per cent carbon, 12@14c. per lb.

Ferromanganese — Domestic, 78@82 per cent, $102.50@$107.50 per gross ton, f.o.b., furnace. Spiegeleisen, 19@21 per cent, $37, f.o.b. furnace; 16@19 per cent, $36.

Ferromolybdenum—$2 per lb. of contained molybdenum for 50 to 55 per cent grades.

Ferrosilicon—10 to 12 per cent, $44 @$51 per gross ton, f.o.b. works; 50 per cent, $82.50@$87.50 delivered.

Ferrotitanium—For 15 to 18 per cent material, $200@$225 per ton, f.o.b. Niagara Falls, N. Y.

Ferrotungsten—85@95c. per lb. of contained W., f.o.b. works. Market firm.

Ferro-uranium—35 to 50 per cent U, $6 per lb. of U contained, f.o.b. works.

Ferrovanadium—$3.75@$4 per lb. of V contained, f.o.b. works.

Metal Products

Copper Sheets—New York base, 24.5c. per lb.; wire, 18.75c. net.

Lead Sheets—Full lead sheets, 10.25c. per lb.; cut lead sheets, 10.50c. in quantity, mill lots.

Nickel Silver—30½c. per lb., for 18 per cent nickel Grade "A" sheets.

Yellow Metal — Dimension sheets, 21⅞c. per lb.; rods, 21⅜c. per lb.

Zinc Sheets—$9.35 per 100 lb., f.o.b. works.

Refractories

Bauxite Brick—$45@$50 minimum, per net ton, f.o.b. shipping point.

Chrome Brick—$50@$52 per net ton, f.o.b. shipping point.

Chrome Cement — $23 per net ton, f.o.b. shipping point.

Firebrick—First quality, $40@$46 per M., Pennsylvania, Ohio, and Kentucky works; second quality, $36@$41.

Magnesite Brick — 9-in., straights $65@$68 per net ton, f.o.b. works.

Magnesite Cement—$45 per net ton, f.o.b. shipping points.

Silica Brick—$42@$44 per M., Pennsylvania; $47@$50, Indiana; $48@$50, Alabama.

[1]**Zirkite**—Powdered, $50@$60 per ton; brick, $100 per ton.

The Iron Trade

Pittsburgh, Feb. 27, 1923

Advances in market prices have occurred in the last week in bars, shapes, plates, sheets, and tin plates, the minimum on bars, shapes, and plates going up $1 a ton to $2.25. Sheets are up from $3 to $8 a ton, independents having advanced more than the Steel Corporation.

Pig Iron—Offerings of basic and foundry at former prices have been absorbed and the market is up $1, bessemer being unchanged. Predictions are common that the market will be at $30 before long. Bessemer, $28; basic, $27; foundry and malleable, $28, f.o.b. Valley furnaces.

Connellsville Coke—Spot and contract furnace coke are both higher, at $7@$7.25, prompt foundry being $8.25 @$8.75.

[1]Price furnished by Foote Mineral Co., Philadelphia, Pa.

COMPANY REPORTS

United Verde Extension Mining Co.

Copper; Jerome, Ariz.

A report of the operations of the United Verde Extension Mining Co., for the year ended Dec. 31, 1922, states that the ore smelted during the operating ten months of the year amounted to 136,980 dry tons, yielding 31,640,714 lb. of copper, 5,788 oz. of gold, and 238,764 oz. of silver. Copper on hand Dec. 31, 1922, totaled 11,569,156 lb.

The company has done, under its contract with the Jerome Verde Development Co., the 3,000 ft. of work which the option requires, and for the coming year has agreed to do 2,500 ft. of work for that company. As yet no ore of any commercial value has been discovered in Jerome Verde ground.

The table below shows the average cost per pound of copper produced during the year.

Mining	0.0232
Smelting	0.0226
Freight on ore	0.0007
Freight on bullion, refining and selling	0.0211
Other expenses	0.0017
	0.0693

These costs do not include depreciation, reserve to return capital (depletion), or taxes.

Estimated tonnage and average is 1,036,166 tons, averaging 9.7 per cent copper, .03 oz. gold, and 2.0 oz. silver.

Statement of Earnings

Gross revenue from metals and ore produced		$4,538,588.36
Other revenue		271,241.54
		$4,809,829.90
Deductions		
Mine and smelter operating, freight, refining and selling expenses	$2,169,328.94	
Other expenses	408,460.13	
		2,577,789.07
Earnings from operations		$2,232,040.83
Less		
Amounts written off to reserves for depletion and depreciation		2,752,872.09
Net loss to surplus		$520,831.26

Balance Sheet Dec. 31, 1922

ASSETS

Mining property, including appraised value of developed ore body		$41,647,699.14
Less depletion reserve		15,953,344.33
		$25,694,354.81
Smelter plant, mine equipment and buildings	$5,880,242.31	
Less depreciation reserve	2,853,524.21	
		3,026,718.10
Investments, at cost		1,467,136.43
Land and ranches		269,768.42
Accounts and notes receivable, including interest accrued		967,166.12
Inventories of materials and supplies		333,241.98
Cash in banks and on hand		1,067,431.78
Liberty bonds, at par		3,364,350.00
Due on metals sold, ore and bullion on hand		2,525,408.93
		$38,715,576.57

LIABILITIES

Capital stock, authorized		$750,000.00
Less treasury stock		225,000.00
		$525,000.00
Accounts payable, including taxes and other accrued charges		1,108,492.17
Reserve for liability insurance		84,098.33
Surplus from appraisal of developed orebodies, balance Jan. 1, 1922	$38,425,000.00	
Less part of dividend 23, together with dividends 24, 25, and 26 refunded	906,182.67	
		37,518,817.33
		$39,236,407.83
Surplus account, Jan. 1, 1922	$406,317.33	
Less dividend 22 and part of 23	406,317.33	
	nil	
Less net loss for 1922	$520,831.26	
Deduct debit balance on surplus account		520,831.26
		$38,715,576.57

The New Jersey Zinc Co.

A statement of the operating results of The New Jersey Zinc Co. for the quarter ended Dec. 31, 1922, follows:

Income (including dividends from subsidiary companies) after deductions for expenses, taxes, maintenance, repairs, betterments, depreciation and contingencies		$1,678,835.45
Deduct interest on first mortgage bonds		40,000.00
Net income		$1,638,835.45
Deduct interest on stock:		
Subscriptions	$2,838.55	
Employees' profit sharing distribution	360,000.00	
Dividend 2 per cent extra, payable Jan. 10, 1923	964,706.00	
Dividend 2 per cent payable Feb. 10, 1923	964,706.00	2,292,250.55
Balance provided from surplus of previous quarters		$653,415.10

SUMMARY

Net income for the first quarter	$1,086,080.37
Net income for the second quarter	1,597,161.16
Net income for the third quarter	1,732,570.81
Net income for the fourth quarter	1,638,835.45
Net income for the year	$6,054,647.79

Deduct dividends declared	$4,768,152.00	
Interest on stock subscriptions	34,384.26	
Employees profit sharing distribution	360,000.00	5,162,536.26
Surplus for the year		$892,111.53

Wright-Hargreaves Mines, Ltd.

Gold, Silver; Kirkland Lake, Ontario

A report of operations of the Wright-Hargreaves Mines, Ltd., for 1922 states that during the year 66,181 tons of ore were treated and the bullion received therefrom amounted to $762,752.84, with an average value per ton of $11.52. The treasurer's report follows:

Bullion production		$762,752.84	
Operation costs			
Development and exploration	$86,095.27		
Stoping	92,837.29		
	$178,932.56		
Transporting ore (hoisting)	$31,460.96		
Milling charges	106,662.91		
Market bullion	3,910.09		
General and undistributed charges	58,797.56		
Depreciation plant and equipment	38,357.95		
		418,122.03	
From operation		$344,630.81	
Other income		$16,792.48	
			$361,423.29

Balance sheet as of Dec. 31, 1922, is given as follows:

Current assets			$274,125.44
Capital assets			
Mining properties		$1,500,000.00	
Plant and equipment, Jan. 1, 1922	$359,865.92		
Additions 1922	43,119.21		
	$402,985.13		
Less depreciation	58,110.71	344,874.42	
Preliminary development cost	$269,682.08		
Less written off	68,847.25	200,834.83	
			$2,045,792.25
			$2,319,834.69
Current liabilities			108,414.02
Capital stock			
Authorized and issued		$2,750,000.00	
Less shares discount		545,003.20	
			$2,204,996.80
Surplus			
Balance from 1921		$186,068.47	
Net from operation 1922		361,423.29	
		$547,491.76	
Less			
Dividends paid 1922	$412,500.00		
Dividend payable Jan. 2, 1923	68,750.00		
1922 taxes payable 1923	23,418.34		
Preliminary development charged off	36,399.55	541,067.89	
Balance free surplus			6,423.87
			$2,319,834.69

METAL STATISTICS

Monthly Average Prices of Metals

Silver

	New York		London		Sterling Exchange	
	1922	1923	1922	1923	1922	1923
January	65.450	65.668	35.035	31.928	421.750	465.053
February	65.290	64.313	33.891	30.875	435.511	468.631
March	64.440		33.269		436.912	
April	66.575		34.080		440.715	
May	71.154		36.023		444.106	
June	71.149		35.900		444.615	
July	70.245		35.644		444.165	
August	69.417		34.957		446.069	
September	69.515		35.305		442.800	
October	68.015		34.498		443.583	
November	65.177		32.882		447.484	
December	63.905		31.383		460.440	
Year	67.528		34.406		442.346	

New York quotations cents per ounce troy, 999 fine, foreign silver. London, pence per ounce, sterling silver, 925 fine.

Copper

	New York		London			
	Electrolytic		Standard		Electrolytic	
	1922	1923	1922	1923	1922	1923
January	13.465	14.510	65.226	64.494	72.321	71.409
February	12.864	15.355	60.250	67.700	66.125	74.500
March	12.567		59.245		65.739	
April	12.573		58.799		64.028	
May	13.111		61.092		66.554	
June	13.575		61.988		69.333	
July	13.654		63.137		70.321	
August	13.723		63.784		69.932	
September	13.748		63.113		70 917	
October	13.632		62.773		70.693	
November	13.598		62.795		70.216	
December	14.074		63.267		70.132	
Year	13.382		62.123		68.859	

New York quotations, cents per lb. London, pounds sterling per long ton.

Lead

	New York		St. Louis		London	
	1922	1923	1922	1923	1922	1923
January	4.700	7.633	4.388	7.571	23.667	27.119
February	4.700	8.050	4.396	8.093	20.681	28.519
March	4.720		4.421		21.266	
April	5.115		4.946		22.993	
May	5.420		5.281		24.462	
June	5.745		5.563		24.685	
July	5.729		5.447		24.869	
August	5.824		5.537		24.580	
September	6.110		5.868		24.131	
October	6.530		6.338		25.551	
November	7.047		6.868		26.199	
December	7.163		6.978		26.079	
Year	5.734		5.503		24.097	

New York and St. Louis quotations, cents per lb. London, pounds sterling per long ton.

Tin

	New York				London	
	99%		Straits			
	1922	1923	1922	1923	1922	1923
January	31.480	37.986	32.100	39.173	163.065	181.852
February	29.835	40.693	30.767	42.011	149.850	190.513
March	28.426		29 171		143 152	
April	29.810		30.605		149.840	
May	30.149		30.971		150.163	
June	30.707		31.497		152.512	
July	31.025		31.733		156.149	
August	32.134		32.380		160.006	
September	32 075		32.395		160.065	
October	33.935		34.600		170.563	
November	35.911		36.734		179.341	
December	36.480		37.695		178.697	
Year	31.831		32.554		159.450	

New York quotations, cents per lb. London, pounds sterling per long ton.

Zinc

	St. Louis		London	
	1922	1923	1922	1923
January	4.691	6.815	26.321	35.733
February	4.485	7.152	24 213	35.613
March	4.658		25.467	
April	4.906		26.576	
May	5.110		27.304	
June	5.346		27.893	
July	5.694		29.042	
August	6.212		31.170	
September	6.548		31.750	
October	6.840		34.528	
November	7.104		38.011	
December	6.999		37.757	
Year	5.716		30.003	

St. Louis quotations, cents per pound. London, pounds sterling, per long ton.

Antimony, Quicksilver and Platinum

	Antimony (a)		Quicksilver (b)		Platinum (c)	
	New York		New York		New York	
	1922	1923	1922	1923	1922	1923
January	4.463	6.884	49.960	72.731	97.260	112.462
February	4.416	7.290	48.295	70.636	89.545	113.273
March	4.319		50.204		87.500	
April	4.980		52.280		87.500	
May	5.467		54.885		85.529	
June	5.145		55.115		87.212	
July	5.091		55.000		90.180	
August	5.315		57.593		98.370	
September	6.580		67.640		117.280	
October	6.905		72.560		109.440	
November	6.584		71.521		108.000	
December	6.382		72.300		113.600	
Year	5.471		58.946		97.618	

(a) Antimony quotations in cents per lb. for ordinary brands. (b) Quicksilver in dollars per flask. (c) Platinum in dollars per ounce.

Pig Iron, Pittsburgh

	Bessemer		Basic		No. 2 Foundry	
	1922	1923	1922	1923	1922	1923
January	21.55	29.27	20.15	27.35	21.34	28.77
February	21.46		19.71		20.88	
March	21.35		19.96		20.83	
April	22.50		21.26		22.70	
May	26.36		26.87		25.96	
June	26.96		26.96		25.96	
July	26.77		26.33		25.97	
August	30.44		27.18		30.81	
September	35.27		34.70		36.79	
October	35.27		31.77		33.40	
November	33.52		29.37		30.55	
December	29.87		26.34		27.69	
Year	27.61		25.88		26.91	

In dollars per long ton.

Monthly Crude Copper Production

	1922			
	October	November	December	Jan., 1923
Alaska shipments	6,771,700	8,959,037	7,937,421	4,698,184
Washoe Smelter	15,980,000	15,500,000	15,250,000	16,250,000
Calumet & Arizona	3,916,000	3,298,000	3,582,000	3,738,000
Calumet & Hecla	(c)	(c)	(c)	(c)
Other Lake Superior	(c)	(c)	(c)	(c)
Chino	(c)	(c)	(c)	(c)
East Butte	(c)	(c)	(c)	(c)
Inspiration	(c)	(c)	(c)	(c)
Miami	6,172,000	5,636,000	5,336,447	5,679,000
Nevada Cons.	(c)	(c)	(c)	(c)
New Cornelia	3,226,618	3,178,556	3,256,547	3,034,000
Old Dominion	2,772,000	2,934,000	2,150,000	2,250,000
Phelps Dodge	6,984,000	9,890,000	6,697,000	7,783,000
Ray	(c)	(c)	(c)	(c)
Shattuck Arizona	(a)	(c)	(c)	(c)
Southwest Metals Co.	1,000,000	1,020,000	1,075,000	971,180
United Verde	(c)	(c)	(c)	(c)
United Verde Extension	3,760,234	3,670,206	3,026,334	3,083,500
Utah Copper	(c)	(c)	(c)	(c)
Others, estimated	11,500,000	11,900,000	10,000,000	10,500,000
Total United States	.....	.....	.....	.....
Imports: Ore and concentrates, matte	7,597,753	.....	.....	.....
Imports of black and blister, unrefined	20,981,156	.....	.....	.....
Imports of refined and old	13,350,263	.....	.....	.....
Grand total	.....	.....	.....	.....
Backus & Johnston	(c)	(c)	(c)	(c)
Boleo	1,214,925	1,128,409	1,389,150	1,280,554
Cananea	(c)	(c)	(c)	(c)
Cerro de Pasco	(c)	(c)	(c)	(c)
Chile	(c)	(c)	(c)	(c)
Cons. M. & S. of Canada	(a)	(a)	(a)	(a)
Falcon Mines	582,000	558,000	.....	.....
Furukawa	3,284,003	2,878,405	.....	.....
Granby Cons.	2,638,414	3,975,000	3,266,200	.....
Hampden Cloncurry	(c)	(c)	.....	.....
Katanga	8,352,540	8,330,500	10,050,370	9,223,515
Mount Morgan	940,000	840,000	.....	.....
Mount Lyell	588,000	962,000	.....	.....
Phelps Dodge Mexican	2,732,000	3,533,000	2,558,000	2,850,000
Sumitomo	2,596,060	3,184,772	.....	.....
Wallaroo & Moonta	(a)	(a)	(a)	(a)

Comparative Annual Copper Production

	1919	1920	1921	1922
January	135,733,511	121,903,744	90,596,597	32,010,292
February	111,649,512	117,540,000	86,682,941	45,957,530
March	102,040,460	120,309,316	91 046,345	55,705,760
April	98,808,998	116,078,871	46,946,523 (b)	76,601,000
May	92,652 975	114,964,207	25,310,511 (b)	88,714,000
June	95,856,570	116,107,856	24,623,693 (b)	93,740,000
July	100,369,247	109,729,610	22,033,739 (b)	91,000,000
August	107,994,040	112,460,254	23,248,398 (b)	101,188,000
September	108,703,075	104,919,562	23,855,316 (b)	96,408,000
October	115,143,143	105,231,571	23,231,572 (b)	103,273,000
November	117,289,735	106,700,178	28,341,442	.....
December	102,997,633	95,709,009	29,629,137	.....

(a) No copper produced during this month. (b) Department of Commerce. (c) Not available.

MINING STOCKS

Week Ended Feb. 24, 1923

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Ahmeek	Boston	72	65	72	Dec. '22, Q	$1.00
Alaska-Br. Col.	N. Y. Curb	2⅜	2⅛	2⅜	.....	....
Allouez	Boston	29	26	27½	Mar. '19	1.00
Anaconda	New York	51⅜	50½	51	Nov. '20, Q	1.00
Arcadian Consol.	Boston	3⅜	3	3⅜	.....	....
Ariz. Com'l.	Boston	11⅛	10⅜	11⅛	Oct. '18, Q	0.50
Bingham Mines	Boston	18⅜	18⅛	18⅛	Sept. '19, Q	0.25
Calumet & Arizona	Boston	63¼	61	62¼	Dec. '22, Q	0.50
Calumet & Hecla	Boston	360	315	360	Dec. '22, Q	5.00
Canada Copper	N. Y. Curb	*4	*2	*4	.....	....
Centennial	Boston	10	9	10	Dec. '18, SA	1.00
Cerro de Pasco	New York	47⅜	45⅝	47⅛	Mar. '21, Q	0.50
Chile Copper	New York	30⅛	29⅜	39⅞	.....	....
Chino	New York	29⅞	26⅜	29⅛	Sept. '20, Q	0.37
Copper Range	Boston	44½	42	43½	Mar. '22, Q	1.00
Crystal Copper	Boston Curb	1 7/16	1⅛	1⅛	.....	....
Davis-Daly	Boston	5	3	4⅜	Mar. '20, Q	0.25
East Butte	Boston	10⅞	10⅛	10¼	Dec. '19, A	0.50
First National	Boston Curb	57	50	56	Feb. '19, SA	0.15
Franklin	Boston	2⅛	2	2⅛	.....	....
Gadsden Copper	N. Y. Curb	*75	*70	*75	.....	....
Granby Consol.	New York	30⅛	28⅛	28⅛	May '19, Q	1.25
Greene-Cananea	New York	30⅛	29⅜	30⅛	Nov. '20, Q	0.50
Hancock	Boston	3	2⅛	3	.....	....
Howe Sound	N. Y. Curb	3⅛	3⅛	3⅛	Jan. '21, Q	0.05
Inspiration Consol.	New York	41⅛	40⅜	41⅛	Oct. '20, Q	1.00
Iron Cap	Boston Curb	7	6½	6⅞	Sept. '20, K	0.25
Isle Royale	Boston	29⅜	28⅞	29⅛	Dec. '22, K	0.50
Kennecott	New York	43¼	41⅞	42⅛	Jan. '23, K	0.75
Keweenaw	Boston	2	1⅜	1¼	.....	....
Lake Copper	Boston	4⅜	4⅛	4⅛	.....	....
Magma Copper	New York	36½	33⅞	36⅝	Jan. '19, Q	0.50
Mason Valley	N. Y. Curb	2⅜	2	2	.....	....
Mass Consolidated	Boston	3	2⅞	3	Nov. '17, Q	1.00
Miami Copper	New York	30⅛	29⅛	29⅞	Feb. '23, Q	0.50
Michigan	Boston	3⅛	2⅞	3⅛	.....	....
Mohawk	Boston	63	61½	62	Nov. '22, Q	1.00
Mother Lode Coa.	New York	14	13	13⅛	Dec. '22, K	0.50
Nevada Consol.	New York	17⅛	16⅛	16⅛	Sept. '20, Q	0.25
New Cornelia	Boston	21⅞	20	21	Feb. '23, Q	0.25
North Butte	Boston	11⅝	10⅞	11⅛	Oct. '18, Q	0.25
Ohio Copper	N. Y. Curb	*65	*52	*55	.....	....
Old Dominion	Boston	28	25½	27½	Dec. '18, Q	1.00
Osceola	Boston	39⅜	37	39⅛	Dec. '22, K	1.00
Phelps Dodge	Open Mar.	†180	†170	....	Jan. '23, Q	1.00
Quincy	Boston	44⅜	42⅜	44⅜	Mar. '20, Q	1.00
Ray Consolidated	New York	16⅝	15⅞	16	Dec. '20, Q	0.25
Ray Hercules	N. Y. Curb	1⅝	1⅝	1⅜	.....	....
St. Mary's Min. Ld.	Boston	48	47	48	Apr. '22, K	2.00
Seneca Copper	Boston	12	11⅝	12	.....	....
Shannon	Boston	*95	*75	*90	Nov. '17, Q	0.25
Shattuck Arizona	New York	10⅜	10	10⅝	Jan. '20, Q	0.25
South Lake	Boston	†1	†*50	*50	.....	....
Superior & Boston	Boston	3⅛	3⅛	3⅜	.....	....
Tenn. C. & C. cfs.	New York	12⅜	12⅜	12⅜	May '18, I	1.00
Tuolumne	Boston	*62	*50	*50	May '13,	0.10
United Verde Ex.	N. Y. Curb	31⅜	29½	31	Nov. '22, Q	0.25
Utah Consol.	Boston	2½	1½	2½	Sept '18,	0.25
Utah Copper	New York	71	68¼	69½	Dec. '22, Q	0.50
Utah Metal & T.	Boston	1⅜	1⅛	1⅛	Dec. '17,	0.30
Victoria	Boston	1⅜	1⅛	1⅜	.....	....
Winona	Boston	1¼	1	1⅛	.....	....
Wolverine	Boston	11	9	10¼	.....	....
NICKEL-COPPER						
Internat. Nickel	New York	16¼	15⅛	15¼	Mar. '19,	0.50
Internat. Nickel, pfd.	New York	...	...	78½	Feb. '23, Q	1.50
LEAD						
Carnegie Lead & Zinc	Pittsburgh	6	5⅛	5⅛	.....	....
National Lead	New York	130⅛	129⅝	129¾	Dec. '22, Q	2.00
National Lead, pfd.	New York	114	112⅛	112⅛	Dec. '22, Q,	1.75
St. Joseph Lead	New York	21⅝	20¼	20½	Dec. '22, Q, X	0.50
ZINC						
Am. Z. L. & S.	New York	18¼	18	18	May '20,	1.00
Am. Z. L. & S. pfd.	New York	56	56	56	Nov. '20, Q	1.50
Butte C. & Z.	New York	11⅜	11⅛	11⅛	June '18,	0.50
Butte & Superior	New York	34⅛	33	33⅜	Dec. '22,	0.50
Callahan Zn-Ld	New York	12⅝	11⅛	11⅛	Dec. '20, Q	0.50
New Jersey Zn.	N. Y. Curb	177	172	177	Feb. '23, Q	2.00
Yellow Pine	Los Angeles	*80	*80	*80	Sept. '20, Q	0.03
SILVER						
Batopilas Mining	New York	⅜	⅜	⅜	Dec. '07, I	0.12½
Beaver Consol.	Toronto	41	39½	41	May '20, K	0.03
Candelaria	N. Y. Curb	*30	*25	*27	.....	....
Coniagas	Toronto	2.25	2.10	2.15	May '21, Q	0.12½
Crown Reserve	Toronto	*37	*35	*37	Jan. '17,	0.05
Hilltop-Nev.	N. Y. Curb.	1¾	1 5/16	1 11/16	.....	....
Kerr Lake	N. Y. Curb	3	3	3	Jan. '23, Q	0.12½
La Rose	Toronto	*38	*36	*37	Apr. '22,	0.10
McKinley-Dar.-Sav.	Toronto	*19	*18½	*19	Oct. '20, Q	0.03
Mining Corp. Can.	Toronto	1.35	1.29	1.35	Sept. '20, Q	0.12½
Nipissing	N. Y. Curb	6⅛	5⅛	5⅝	Jan. '23, Q, X	0.60
Ontario Silver	New York	...	...	5	Jan. '19, Q	0.50
Temiskaming	Toronto	*34	*30½	*30½	Jan. '20, K	0.04
Trethewey	Toronto	*5½	*4	*5	Jan. '19,	0.05

Stock	Exch.	High	Low	Last		Last Div
GOLD						
Alaska Gold	New York	...	...	¾	.....	....
Alaska Juneau	New York	1⅛	1⅛	1⅛	.....	....
Atlas	Toronto	15	13	14½	.....	....
Carson Hill	Boston	8⅜	8¼	8⅜	.....	....
Cresson Consol. G.	N. Y. Curb	2 11/16	2½	2⅝	Jan. '23 Q.	0.10
Dome Mines	New York	41⅛	40⅜	41⅛	Jan. '23, Q	0.50
Golden Cycle	Colo. Springs	1.02	*95	1.02	Dec. '22, Q	0.02
Hollinger Consol.	Toronto	13.55	13.00	13.40	Feb. '23, M	0.05
Homestake Mining	New York	73	73	73	Feb. '23, M	0.50
Keora	Toronto	*10	*9	*9½	.....	....
Kirkland Lake	Toronto	*52	*49	*52	.....	....
Lake Shore	Toronto	3.70	3.59	3.64	Nov. '22, Q	0.02
McIntyre- Porcupine	Toronto	19.50	18.40	18.40	Jan. '23, K	0.25
Porcupine Crown	Toronto	*14	*12½	*12½	July '17,	0.03
Portland	Colo. Springs	†*40	†*30	*40	Oct. '20, Q	0.01
Schumacher	Toronto	*30	*30	*30	.....	..
Teck Hughes	Toronto	*95	*88½	*88½	.....	..
Tom Reed	Los Angeles	1.19	1.07	1.13	Dec. '19,	0.02
United Eastern	N. Y. Curb	2 5/16	2 1/16	2⅛	Jan. '23, Q	0.15
Vipond Cons.	Toronto	*77	*74	*76	.....	..
White Caps Mining	N. Y. Curb	...	...	*6	.....	....
Wright-Hargreaves	Toronto	3.38	3.32	3.32	Jan. '23,	0.02½
Yukon Gold	N. Y. Curb	*90	*80	*90	June '18,	0.02½
GOLD AND SILVER						
Boston-Mont. Corp.	N. Y. Curb	*12	*9	*11	.....	....
Cons. Virginia	San Francisco	*11½	*10½	*11½	.....	....
Continental Mines	N. Y. Curb	5	5	5	.....	....
Dolores Esperanza	N. Y. Curb	1⅞	1⅜	1⅞	Jan. '23	2.50
Tonopah Belmont	N. Y. Curb	1 7/16	1⅜	1⅜	Jan. '23, Q	0.05
Tonopah Divide	N. Y. Curb	*68	*66	*68	.....	....
Tonopah Extension	N. Y. Curb	3⅛	3	3	Jan. '23, Q	0.05
Tonopah Mining	N. Y. Curb	2⅜	2⅛	2⅛	Jan. '23, SA,	0.15
West End Consol.	N. Y. Curb	1 1/16	1 1/16	1 1/16	Dec. '22, Q	0.05
SILVER-LEAD						
Caledonia Mng.	N. Y. Curb	*9	*8	*8	Jan. '21, M	0.01
Cardiff M. & M.	Salt Lake	*32	*31	*31	Dec. '20,	0.15
Chief Consol.	Boston Curb	4⅞	4⅞	4⅞	Feb. '23, Q	0.10
Columbus Rexall	Salt Lake	*21	*20	*20½	Aug. '22,	0.03
Consol. M. & S.	Montreal	28½	28	28	Oct. '20, Q	0.62½
Eagle & Blue Bell	Boston Curb	2⅜	2⅜	2⅜	Nov. '22, K	0.05
Federal M. & S.	New York	11¼	11	11	Jan. '09,	1.50
Federal M. & S. pfd.	New York	57	53⅜	53⅜	Dec. '22, Q	1.25
Florence Silver	Spokane	*39	*38	*38½	Apr. '19,	0.01½
Hecla Mining	N. Y. Curb	9⅛	9	9⅜	Dec. '22, Q, X	0.50
Iron Blossom Con.	N. Y. Curb	*32	*31	*31	Apr. '22, Q	0.02½
Marsh Mines	N. Y. Curb	...	...	*7	June '21, I	0.02
Park City	Salt Lake	3.45	3.45	3.45	Jan. '23,	0.10
Prince Consol.	Salt Lake	*11½	*10	*10	Nov. '17,	0.02½
Silversmith	Spokane	*47	*42	*44	Oct. '22,	0.01
Simon Silver Lead	N. Y. Curb	*31	*30	*31	.....	....
Tamarack-Custer	Spokane	1.75	1.45	1.45	Jan. '21, K	0.04
Tintic Standard	Salt Lake	2.67½	2.60	2.60	Dec. '22, Q, X	0.10
Utah-Apex	Boston	4	3⅝	4	Nov. '20, K	0.25
IRON						
Bethlehem Steel "B"	New York	67	65⅝	66	Jan. '23	0.25
Char. Iron	Detroit	...	...	1¼	.....	....
Char. Iron, pfd	Detroit	...	...	2¾	.....	....
Colorado Fuel & Iron	New York	30¾	29½	29½	May '21	0.75
Col. Fuel & Iron, pfd.	New York	...	...	105	Feb. '23 Q	2.00
Gt. North'n Iron Ore	New York	33⅜	33⅜	33¾	Dec. '22	1.00
Inland Steel	N. Y. Curb	...	...	47	Dec. '22	0.25
Mesabi Iron	N. Y. Curb	10⅜	10⅜	10⅜	.....	....
Reologle Steel	New York	31⅜	28½	28½	.....	....
Republic I. & S.	New York	58½	56	56½	May '21	1.50
Republic I. S., pfd.	New York	93½	93½	93½	Jan. '22	1.75
Sloss-Sheffield S. & I.	New York	50½	49	50½	Feb. '21	1.50
U. S. Steel	New York	108½	107	107⅝	Dec. '22	1.25
U. S. Steel, pfd.	New York	121	120	121	Feb. '23	1.75
Virginia I. C. & C.	New York	67	55½	64	Jan. '22	1.50
Virginia I.C.&C.,pfd.	New York	80	80	80	Jan '23	2.50
VANADIUM						
Vanadium Corp.	New York	44	41⅜	42	Jan. '21, Q	1.00
ASBESTOS						
Asbestos Corp.	Montreal	69⅜	68⅜	69	Oct. '22, Q	1.50
Asbestos Corp. pfd.	Montreal	...	...	87	Oct. '22, Q	1.75
SULPHUR						
Freeport Texas	New York	21	19⅞	19⅞	Nov. '19, Q	1.00
Texas Gulf	New York	62½	60¼	61	Dec. '22, QX	2.00
PLATINUM						
So. Am. Gold & P.	N. Y. Curb	4⅛	3½	4½	.....	....
MINING, SMELTING AND REFINING						
Amer. Metal	New York	54	52	52½	Dec. '22, Q	0.75
Amer. Metal pfd.	New York	116	116	116	Dec. '22, Q	1.75
Amer. Sm. & Ref.	New York	65⅜	63	63⅞	Mar. '21, Q	1.00
Amer. Sm.& Ref. pfd	New York	101⅞	100⅞	100⅞	Dec. '22 Q	1.75
U. S. Sm. R. & M.	New York	41¼	39	39	Jan. '21, Q	0.50
U.S. Sm.R.& M. pfd.	New York	46	45	45¼	Jan. '23 Q	0.87½

*Cents per share. †Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. K, Irregular. I, Initial. X, Includes extra.

Toronto quotations courtesy Arthur E. Moysey; Spokane, Pohlman Investment Co; Salt Lake, Stock and Mining Exchange; Los Angeles, Chamber of Mines and Oil; Colorado Springs, Colorado Springs Stock Exchange.

NEW MACHINERY AND INVENTIONS

Hydraulic Power vs. Compressed Air as Applied to Rock Drills

By Basil V. Stuart Davies

A rotary hydraulic rock drill has been invented and tested with success at various state quarries in North Wales, which, it is said, will eventually replace the present compressed-air percussive drills, which are a source of danger to the health of operators because of the dust given off by the discharge of exhaust air from the machines. It will be argued that sprays and other devices may be adopted, while a drill is in use, which will eliminate the cause of "miner's pthisis," but in practice, even when these spraying appliances are in use, it is invariably found that minute articles of dust are present in the atmosphere.

It will be stated in favor of compressed air that the use of this force assists or augments ventilation in mines, but if figures are carefully studied it will be seen that the amount of free air given off is negligible, while the horsepower expended to provide the free air would ventilate the entire mine if applied to a fan.

In coal mines the application of water, as a power, will prevent the accumulation of coal dust in and around that area most susceptible to the presence of coal gas (firedamp). Thus another source of danger is removed besides providing the necessary fire-fighting appliances, from the mains carrying power to drills, all the way from the shaft to the working face.

A type of rotary hydraulic rock drill has been in continual use for over three years and is still in excellent condition due to the fact of its being designed to reduce friction to an absolute minimum, both theoretically and practically. There is no intermittent percussive action, and therefore no replacements of damaged parts have been necessary, although working under a pressure of 400 lb. per sq.in. The turbine in this new drill is so arranged that the whole pressure is extracted before the fluid is discharged at the exhaust. Professor Louis has stated that on the Rand it has been found that, taking the average of a large number of plants, it was necessary to apply 28 hp. to the compressor in order to obtain 5 hp. at the drill, and that out of the 5 hp. delivered at the drill only 1.7 hp. ever reached the face of the rock.

When drilling is in progress further losses are involved, which are caused by fragments of stone, already chipped off, remaining at the base of the drill hole. These prevent the succeeding blow delivering its full force upon the rock, by forming a cushion. thereby expending the energy in converting fragments already removed into a fine powder. This energy again reduces the effective work in drilling with compressed air to about 3 hp., which means 99 per cent of wasted energy from compressor to face of bore hole.

In the case of a hydraulic pump and rotary hydraulic drill, assuming the same input of 28 hp. be applied to the pump, about 23.8 hp. would be delivered to the drills and about 14 hp. would represent effective work in rock drilling. This equals 50 per cent of power supplied to the face, as against 1 per cent of compressed-air power.

The rotary hydraulic rock drill is the invention of Moses Kellow, Park and Goesor Quarries, Penrhyndeudraeth, North Wales, and is manufactured under license by Holman Bros., Ltd., Camborne, Cornwall, England, and is known as the "K" type Kellow rock drill. Other advantages claimed over compressed-air percussive drills are that the Kellow drill bores the entire length of the hole with stoppage to change drills, and that it bores a hole of uniform diameter and perfectly round.

Whether the fluid for operating the drill be air or water, it is necessary that this fluid should be under pressure. In the case of air this is produced by an air compressor, and in the case of water by a pump (except when sufficient natural head is available). The stroke of an air compressor consists of two parts—viz, that which brings the air up to working pressure required by the drills and that which delivers the compressed air into the main.

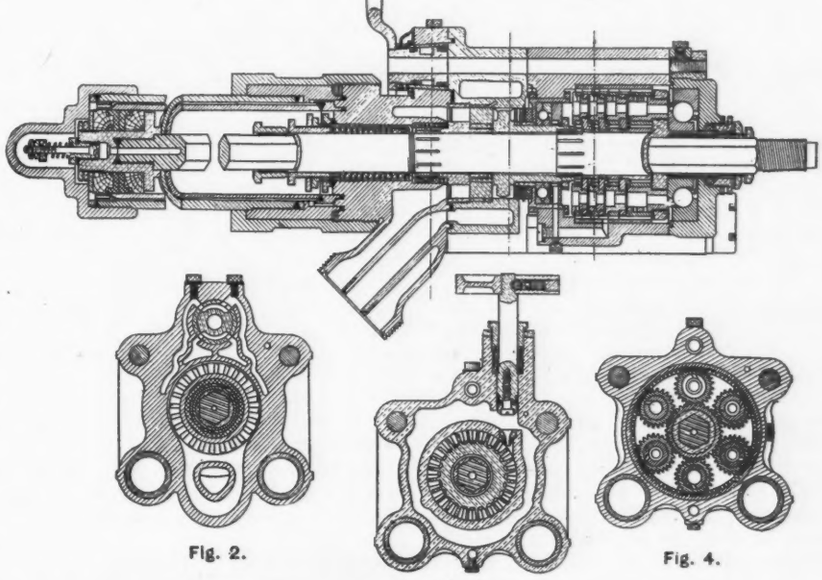
If it were possible to work under ideal conditions—that is, compression without increase of temperature and assuming a working pressure of 80 lb. per sq.in.—about 15 per cent only would represent the latter part of the stroke during which air is being used by the compressor, and this part alone is made use of in the drills, as it is neither usual, nor is it advantageous, that they should use air expansively. When water is substituted for air, the necessity for devoting 85 per cent or even a part of the stroke to bring it up to working pressure is obviated, and the volume delivered into the main is the full 100 per cent (minus any small slip past valves or connections, which is common to both air-compressor and pump). With the use of compressed air this becomes less efficient, as high pressures are used.

An air compressor of given capacity, and delivering air to the drills at 50 lb. pressure per sq.in., would supply nearly the same total available energy to the drills as another of similar capacity delivering air at 100 lb. pressure, the reason for this being that the volume would be less at the higher pressure.

The power required to produce air at 100 lb. pressure per sq.in. would be considerably more than that required at 50 lb. pressure, so that this in itself precludes the use of air for transmission of power other than at comparatively low pressures. With water, 700 lb. up to several tons per square inch can be adopted without involving the objections which are present in the alternative system.

To illustrate the effect of the character of the fluid upon the machines producing the pressure, it may be stated that a displacement capacity about 60 times as great is required for air at 80 lb. per sq.in. pressure as for water of 700 lb. pressure, based upon equal delivery of energy at the drills.

The variations in pressure during the stroke of an air compressor necessitate the use of a complicated type of machine with moving crossheads, connecting rods, cranks, shafts, and



Kellow rotary hydraulic rock drill

Fig. 1, Longitudinal section. Fig. 2, 3 and 4, Transverse sections

heavy flywheels, besides elaborate methods of dissipating heat due to compression and in the case of a two-stage compressor a duplication of the entire plant, with the addition of intercoolers.

Taking the alternative of a simple pump, driven by the commonest source of power—i.e., steam—direct coupling of steam and water cylinders is the mode adopted, and none of the complications of the alternative compressed-air system are involved. By the adoption of a duplex type of pump fitted with a regulating valve, the speed of the pump is automatically varied from a maximum to zero, altering the delivery according to the requirements of the drills and taking power only in proportion to the work done.

A pump may be driven from any source of power other than steam, and in the case of deep mines existing pumping plants may be utilized by the addition of a regulating valve and coupling to the rising main.

There will naturally be some doubts as to weight of drill, nature of steel bit to withstand friction at high speeds, quantity of discharge, and cost of drill.

In the case of discharge this is negligible; water used may be collected in a sump to be used again, with little or no loss. Therefore, in case of only a small feed of water, hydraulic drills can be employed and existing pumping arrangements are not interfered with in any way.

The weight of the drill at present in use is 50 lb., inclusive of the steel. However, this can now be reduced to 39 lb. without lowering the factor of safety, which is extremely high for experimental purposes. Holes may be bored from 1¼ in. up to 4 in. or even with higher diameters without interfering with the mechanism or speed of the drill. By means of simple gearing speed may be reduced from the maximum to conform to the nature of the rock encountered.

The full pressure, adopted to drive the rotary hydraulic drill, is utilized to force the bit into the bore hole, or, rather, against the face of the rock. Thus if 700 lb. per sq.in. is used to rotate the bit, the pressure against the rock face is 700 lb. per sq.in., and uneven and jerky, with the consequent danger of bending or breaking drills and internal mechanism.

As spare parts of the Kellow drill are standard, there is no difficulty of obtaining any part from the manufacturers, and skilled labor is not required to change any part of the simple mechanism.

There is a difficulty to be overcome, and that is the outlay. Not for pumps and main, which are obtainable at less cost than compressors, receivers, or other apparatus, but for the drill itself. The present price is high, owing to the fact of a small demand, as the drill has just been placed on the market. However, with mass production the cost will then compare favorably with other rock-drilling machines on the market.

The difficulty of obtaining a suitable joint for water mains at high pressures has been effectively overcome, and when the new hydraulic rotary drill has been adopted universally it is believed the costs of driving, sinking and stoping will permit the opening up of new fields at present out of the reach of even large syndicates.

INDUSTRIAL NOTES

Magnetic Separation as Applied to Manganese Ore Concentration

The Philipsburg Mining Co., Philipsburg, Mont., recently ordered three Rowand Wetherill, "High Intensity" magnetic separators, which are to be used in the concentration of manganese ore. The machines have four magnets, whereas others of standard design have three magnets, having respectively 30,000-, 60,000- and 100,000-amp. turn magnets. The fourth magnet in the case of the machines for the Philipsburg company is used for extracting tramp iron and the iron coming from the natural wear of the crushers. It is consequently of low-intensity design.

Each of the machines weighs approximately 35,000 lb., and occupies a floor space 5 x 25 ft. It will require three carloads to ship these three units with all of the accessories going with them. Each machine will consume 6½ kw. electric current for the magnets, but will require not more than 3 hp. mechanically to drive. They are being made by the Dings Magnetic Separator Co., Milwaukee, Wis. With the three units now ordered, there will be a battery of five of these machines at the Philipsburg plant.

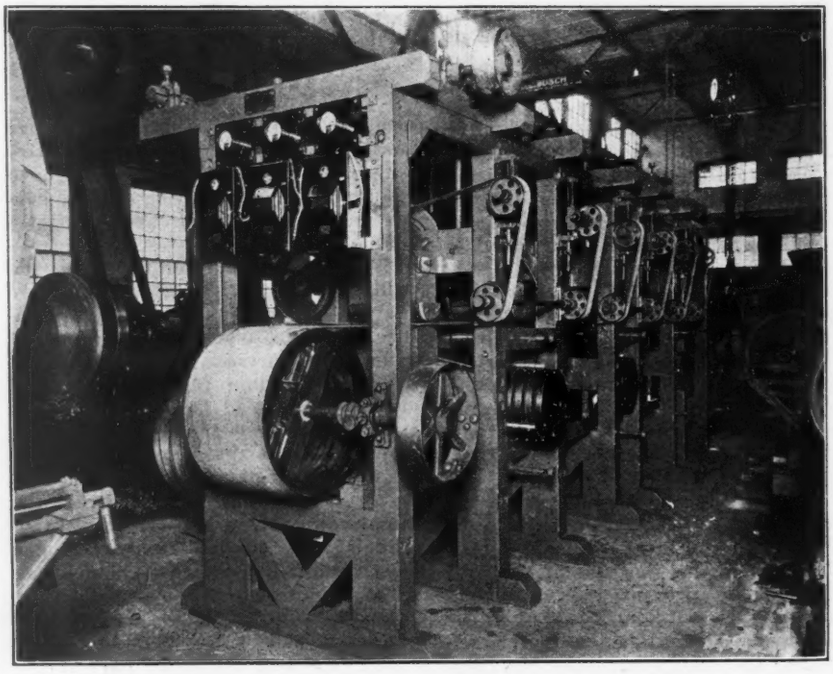
The Webster Manufacturing Co., Chicago, Ill., and Tiffin, Ohio, announces further expansion in connection with its Canadian business. A new corporation has been arranged, the Webster-Inglis, Ltd., 14 Strachan Ave., Toronto, Canada. The facilities of this plant will enable the company to design and manufacture elevating, conveying and power-transmission machinery.

Charles W. Phellis, for the last sixteen months general manager of the E. I. du Pont de Nemour Co.'s pyralin department, and for twenty years before that actively identified with the company, has retired to devote his time to his personal interests. The position of general manager of the pyralin department has been taken by R. R. M. Carpenter, vice-president of the company, who has been actively identified with the development of this and other lines which have been added in recent years to the du Pont company's activities.

TRADE CATALOGS

Handsome Catalog Describes McIntosh & Seymour Diesel Engines

Various phases of the making and utilization of Diesel engines are discussed in an attractive 48-page catalog, just issued by the McIntosh & Seymour Corporation, of Auburn, N. Y. A feature of the booklet is the large number of excellent illustrations that indicate the diversity of uses for which these engines have been chosen by engineers in all parts of the country. Of particular interest to the mining man are two installations for western mining companies. For power plants at remote points the Diesel engine offers particular economy, because of the relative small bulk of the fuel required.



Interior of manganese concentrator at Philipsburg, Mont.